

**Final  
Revision 1**

**Sampling and Analysis Plan/Quality Assurance Project Plan  
2012 Sampling Events**

**Upper Animas Mining District  
Gladstone, San Juan County, Colorado**



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**Signature Page – Sampling and Analysis Plan/Quality Assurance Project Plan –  
Upper Animas Mining District**

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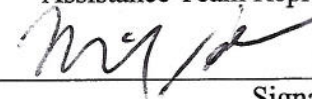
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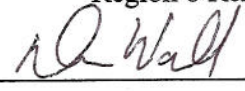
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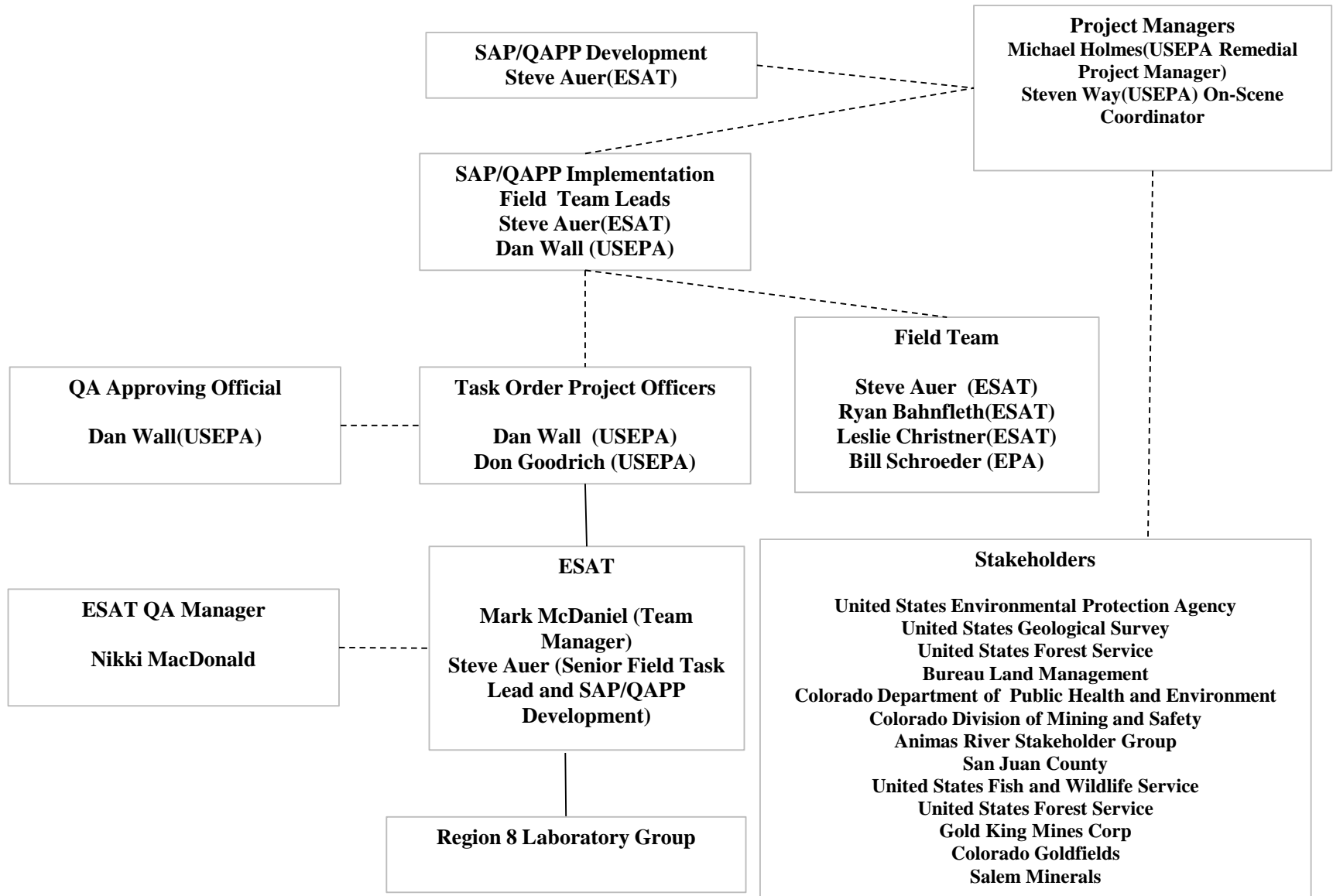
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**Distribution List – Sampling and Analysis Plan/Quality Assurance Project Plan –  
Upper Animas Mining District**

The following is a distribution list of personnel that will receive a copy of the Sampling and Analysis Plan/Quality Assurance Project Plan for the sampling events scheduled in 2012 at the Upper Animas Mining District. Agency and/or contractor affiliations are also listed for each individual.

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Dan Wall	U.S. EPA
Bill Schroeder	U.S. EPA
William Simon	ARSG Project Manager
Stephanie Odell	BLM/USFS Project Manager
Camille Price	CDPHE/DRMS Project Manager
Steven Auer	ESAT Field Task Lead
Mark McDaniel	ESAT Manager
Rob Runkel	USGS

## Organizational Chart



**Project/Task Organization**  
**Sampling and Analysis Plan/Quality Assurance Project Plan**  
**Upper Animas Mining District**

The following is a list of involved personnel, respective agency/contract affiliation, and general responsibilities.

**Managers:**

Michael Holmes	USEPA	Remedial Project Manager
Steven Way	USEPA	On Scene Coordinator
Dan Wall	USEPA	Task Order Project Officer/ QA Approving Official
Mark McDaniel	ESAT	ESAT Team Manager

**Field Team:**

Steve Auer	ESAT	Field Task Lead
Ryan Bahnfleth	ESAT	Field Support
Leslie Christner	ESAT	Field Support
Bill Schroeder	EPA	Field Support

**Laboratory Group:**

Scott VanOvermeiren	ESAT	Inorganic Task Lead
Scott Walker	ESAT	Analytical Support

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### Acronym List

AA	Alternative Action
ARSG	Animas River Stakeholder Group
BLM	Bureau of Land Management
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Register
CLP	Contract Laboratory Program
COPC	Contaminant of Potential Concern
CSM	Conceptual Site Model

DO	Dissolved Oxygen
DQA	Data Quality Assessment
DQO	Data Quality Objectives
DRMS	Division of Reclamation, Mining and Safety
DS	Decision Statement
DSR	Data Summary Report
EDI	Equal Discharge Sampling
ESAT	Environmental Services Assistance Team
EPA	Environmental Protection Agency
ES	Estimation Statement
GPS	Global Positioning System
HASP	Health and Safety Plan
LCS	Laboratory Control Spikes
MIW	Mining-Impacted Waters
PSQ	Principal Study Question
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RPD	Relative Percent Difference
RPM	Remedial Project Manager
SAP	Sampling Analysis Plan
SOP	Standard Operating Procedures
TAL	Target Analyte List
TMDL	Total Maximum Daily Loads
USFS	United States Forest Service
WQCD	Water Quality Control Division



## **1.0 Introduction**

The Environmental Protection Agency (EPA), in cooperation with participating stakeholders will be sampling the Cement Creek and the Animas River as part of a Remedial Investigation. Mobilization and watershed sampling activities are scheduled to be performed during 2012 high (May) and low (October) flow conditions

This Sampling and Analysis Plan (SAP) has been prepared in accordance with the EPA “*Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4)*”, *Requirements for Quality Assurance Project Plans (QA/R-5)* and the “*Guidance for Quality Assurance Project Plans (EPA QA/G-5)*”, (U.S. Environmental Protection Agency (EPA) 2006; EPA 2001; EPA 2002). This SAP is designed to guide field work that will include the collection of surface water samples and flow measurements, including field Quality Assurance/Quality Control (QA/QC) samples.

Laboratory analyses will include total and dissolved Target Analyte List (TAL) metals, hardness (calculated from calcium and magnesium concentrations in the dissolved ratio) anions, alkalinity, and selected isotopes. All samples will be analyzed either directly or indirectly through the ESAT Region 8 Laboratory. Field-collected measurements of aqueous samples will include temperature, pH, specific conductivity, dissolved oxygen (DO), and flow measurements will be made.

Sampling procedures will adhere strictly to those outlined in the attached ESAT Region 8 Standard Operating Procedures (SOPs). Deviations from the SAP will be documented in the site dedicated field notebook and reported in the Sampling Activities Report. Deviations that result in major modifications to the SAP will be noted and incorporated into all addenda to the SAP, which will be followed for subsequent sampling events. A brief addendum to the SAP will be created for each subsequent sampling event by updating applicable figures, tables, and attachments. Data obtained from these investigations will be used in accordance with the provisions outlined in the Data Quality Objectives (DQO's).

## **2.0 Problem Definition and Background**

The discovery of gold and silver brought miners to the Silverton area and Animas Mining District in the early 1870's. The discovery of silver in the base-metal ores was the major factor in establishing Silverton as a permanent settlement. Between 1870 and 1890, the richer ore deposits were discovered and mined to the extent possible. Not until 1890 was any serious attempt made to mine and concentrate the larger low-grade ore bodies in the area. By 1900, there were 12 concentration mills in the valley sending products to the Kendrick and Gelder Smelter near the mouth of Cement Creek. Mining and milling operations slowed down circa 1905, and mines were consolidated into fewer and larger

operations with the facilities for milling large volumes of ore. After 1907, mining and milling continued throughout the basin whenever prices were relatively favorable.

Gladstone, located about eight miles upstream of Silverton on Cement Creek, is the site of an historic mining town developed in the 1880s commensurate with the onset of mining in the surrounding area. The town was the central location and railroad terminus for the milling and shipping of mine ores from the surrounding three-square-mile valley. The town declined in the 1920s and no remnants of the town remain. By the 1970's only one year-round producing mine (Sunnyside Mine) remained in the county. This mine ceased production in 1991, and has since undergone extensive reclamation efforts. The Gold King Mine's permit with DRMS is currently in inactive status; however, landowners hope to rehabilitate the mine. Both the Sunnyside and Gold King properties were partially accessed through the American Tunnel that has its portal in Gladstone.

Previously the American Tunnel drained as much as 1,600 gallons per minute (gpm) of water from the mines. A lime feed and settling pond type treatment facility was constructed in Gladstone in 1979 by Standard Metals Corporation. Water discharging from the American Tunnel was treated as required by the water discharge permit. The facility operations and mine ownership was later transferred to the Sunnyside Gold Corporation (SGC). Under jurisdiction of a court consent decree to terminate their discharge permit, SGC installed several bulkheads within the Sunnyside Mine that greatly reduced the amount of discharge from the American Tunnel. Seventy to one hundred gpm continue to discharge presumably from near surface groundwater. All terms of the consent decree were met by SGC in 2002.

In January 2003 the treatment facility, operations, and permit were transferred to the Gold King Mines Corporation. The settling ponds were deeded to the San Juan Corporation. by SGC prior to the lease between the Gold King Mines and San Juan Corporations. The treatment facility continued to treat the remaining American Tunnel discharge and the Gold King discharge until September 2004. The San Juan Corporation. required SGC to reclaim the four settling ponds (completed in 2005) following termination of the San Juan Corporation and SGC lease. The Gold King Mines Corporation was subsequently evicted and the balance of the Gold King Mines Corporation land was acquired by the San Juan Corporation as the lien holder. The American Tunnel portal reclamation and removal of some out buildings were completed in 2006. The BLM manages land associated with the American Tunnel portal and vicinity; however, the San Juan Corporation. owns the majority of the land surrounding the portal.

Numerous historic and now abandoned mines exist within a two-mile radius of Gladstone. They include: the Upper Gold King 7 Level, American Tunnel, Grand Mogul, Mogul, and Red and Bonita, Evelyne, Henrietta, Joe and John, and Lark mines. Some of these mines have acid mine drainage that flows between 30 and 300 gpm directly or indirectly into Cement Creek and eventually into the Animas River, the confluence located about eight miles downstream of Gladstone. The ARSG, BLM, DRMS and private stakeholders have completed remediation projects at the Evelyne, Henrietta, Joe and John, and Lark mines. The remaining sites located in the Cement Creek drainage that will be the focus of these sampling efforts include the American Tunnel, Grand Mogul, Mogul, Red and Bonita, and the Upper Gold King 7 Level.

The monitoring and assessment activities described in this SAP are designed to:

- Determine the sources of site related metals loading in the Cement Creek watershed and subsequent loading to the Animas
- Determine the nature and extent of mining related contamination in the Animas River.
- Collect data of sufficient quality to determine the contaminants of potential ecological concern as part of a screening level ecological risk assessment (SLERA)

### **3.0 Project/Task Description**

Sampling events will be conducted in 2012 to evaluate the extent of metals contamination in the Cement Creek drainage and metals contribution to the Animas River. Data generated from the sampling events will be used in accordance with the provisions outlined in the DQO (Section 4.0). The following data will be collected during the events:

- Real-time field water quality parameters – pH, conductivity, dissolved oxygen, temperature, and Global Positioning System (GPS) locations (if needed)
- Stream flows – using SonTek flow meters, flumes (where necessary), and stream flow measurement instrumentation that is already in place
- Surface water including streams and adit discharges – dissolved metals, total recoverable metals, selected isotopes, alkalinity, and anions
- Photolog – Site photographs will be collected for all sampling locations

### **3.1 Development of a Conceptual Model**

This section addresses the development of a conceptual site model (CSM) based on the current understanding of the conditions of the Upper Animas watershed. The CSM is an

evaluation of the contaminant sources, primary release mechanisms, contaminant fate and transport (including impacted media), exposure routes, and potential receptor groups.

The contamination at the site is the result of mining and milling activities at various locations within the site boundaries resulting in the release of mine wastes containing elevated concentrations of arsenic and heavy metals.

Contaminants may be released from mine waste rock piles and tailing piles through surface water runoff, wind and water erosion, infiltration/leaching to groundwater, biotic uptake, or waste transport by human activity. Adits may discharge contaminants to surface water or leach them to groundwater. All these sources have the potential to impact aquatic communities. Erosion and aerial deposition of contaminants to terrestrial environments or waste transport by human activity may also pose risk to terrestrial receptions.

### **3.2 Planning Team and Stakeholders**

The following sections list the members of the DQO planning team, primary decision makers, and parties who may be impacted by the results of this study or who may use this data generated as a result of the DQO process.

#### **3.2.1 DQO Planning Team**

The following table includes the DQO planning team members, respective organizations, and affiliation with that organization.

**Table 3.2-1 DQO Planning Team Members**

<b>Name</b>	<b>Organization</b>	<b>Area of Technical Expertise</b>
Michael Holmes	USEPA Region 8	Remedial Project Manager
Dan Wall	USEPA Region 8	Task Order Project Officer
Steven Way	USEPA Region 8	On-Scene Coordinator
Steve Auer	ESAT	Biologist
William Simon	ARSG	Project Manager

#### **3.2.2 Decision Maker**

The decision-maker has the ultimate authority for making final decisions based on the recommendations of the DQO team. The decision-maker for this event is Michael Holmes, the USEPA Region 8 Remedial Project Manager for this site.

### 3.2.3 Stakeholder

Stakeholders are parties who may be affected by the results of the study and/or persons who may later use the data resulting from the DQO process. Table 3.2-2 lists the impacted organizations/stakeholders and the individuals that are representing those organizations.

**Table 3.2-2 Stakeholders**

<b>Organization</b>	<b>Represented By</b>
<b>USEPA Region 8</b>	<b>Michael Holmes</b>
<b>ARSG</b>	<b>William Simon</b>
<b>USGS</b>	<b>Rob Runkel</b>
<b>Gold King Mines Corp</b>	<b>Todd Hennis</b>
<b>BLM</b>	<b>Lisa Richardson</b>
<b>CDPHE</b>	<b>Craig Gander</b>
<b>Colorado Division of Reclamation,</b>	<b>Cristin Brown</b>
<b>Sunnyside Gold Company</b>	<b>Larry Perino</b>

## 4.0 Data Quality Objectives

The DQO process specifies project decisions, the data quality required to support those decisions, specific data types needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified. The DQO process consists of the following seven steps:

1. State the problem,
2. Identify the goal of the study,
3. Identify the information inputs,
4. Define the boundaries of the study,
5. Develop the analytic approach,
6. Specify performance or acceptance criteria,
7. Develop the plan for obtaining data.

During the first six steps of the process, the planning team develops decision performance criteria that will be used to develop the data collection design. The final step of the process involves developing the data collection design based on the DQOs. A brief discussion of these steps and their application to this project are provided in the following sections.

#### **4.1 State the Problem**

Cement Creek, the receiving stream for the discharge of the American Tunnel, Red & Bonita, Mogul, and Gold King Level 7 is unable to support aquatic life. Cement Creek is a major contributor of metals and acidity to the Animas River. The river has goal-based cold water aquatic life standards. Presently 15 TMDL allocations are not being met for Cement Creek and the Animas River.

Existing and historical data suggest that conditions have been changing over the last three years at several locations where mining-impacted waters (MIW) enter upper Cement Creek. For example, flows have been increasing at the Red and Bonita mine and the upper Gold King 7 Level. In addition, the data suggests increased concentration of aluminum, cadmium, copper, manganese, and zinc observed in Cement Creek and downstream in the Animas River (A72) in the years 2005 through 2007. These increases have coincided with the 2005 cessation of active water treatment in Gladstone and the installation of bulkheads at the American Tunnel. Therefore, additional characterization of the watershed is needed to determine seasonal and annual variability in water quality and metals loads.

Protection of aquatic life in the Animas River from the harmful effects of metal is a primary concern for this investigation. Determining which remedial actions will provide that protection based on simple mass loading calculations has unacceptable levels of uncertainty and is likely to overestimate the benefits a remedial action (Walton-Day et al., in press). In order to reduce that uncertainty and more accurately estimate post remediation metals concentrations, a reactive solute transport, OTEQ (One-dimensional Transport with Equilibrium Chemistry) will be developed (Runkle, 2010).

#### **4.2 Identify the Goal of the Study**

The purpose of this step is to define the principle study questions (PSQs) that this study will attempt to resolve. The PSQs will help determine appropriate data inputs and potential alternative actions. Principle study questions can be used to develop decision statements when the potential alternative actions have been determined to resolve the problem. In situations where the outcomes may not lead to specific decisions or the information may be used to gain a greater understanding of existing data, estimation statements are more appropriate. Estimation statements are more applicable to the nature of the principle study questions being investigated in these sampling efforts.

The principle study questions (PSQ's) are as follows:

PSQ1 - What is the seasonal and annual variability in water chemistry, metals loads, and discharges into Cement Creek sources?

PSQ2 - What is the nature and extent of mining related contamination in the Cement Creek watershed and the upper Animas River?

PSQ3 – What are the Contaminants of Potential Ecological Concern (COPEC)?

PSQ4 – What are the effects of various remediation scenarios on water quality in the Animas River?

### **Estimation Statements**

*Principle Study Question 1: What is the seasonal and annual variability in water chemistry, metals loads, and discharges into Cement Creek sources?*

Results will be compared to those of previous sampling events to examine seasonal and annual variability in water chemistry, metals loads and amount of water discharged from the upper Cement Creek watershed. It is of particular importance to determine whether conditions have stabilized following actions taken at mines in the watershed. If it is determined that conditions have stabilized further monitoring may not be necessary or may be modified.

*Principle Study Question 2: What is the nature and extent of mining related contamination and chemistry in the Cement Creek watershed and the upper Animas River?*

Results of all 2012 sampling events will be evaluated to determine if characteristic chemical signatures from individual adits can be identified. Historically, there has not been sufficient data collected from between the town of Gladstone and the mouth of Cement Creek. Additional sampling stations will be established to determine if there are additional, previously uncharacterized loads to this reach of the creek.

Data will be also be collected to determine the concentration of site related contaminants in sediments during low flow conditions in the Animas River and attempts will be made to establish additional Animas River sampling locations.

*Principle Study Question 3: What are the Contaminants of Potential Ecological Concern (COPEC)?*

The initial step in determining whether chemical contamination is posing risks to ecological receptors is the development of a Screening Level Risk Assessment (SLERA). Results of the SLERA will determine which chemicals do not require further evaluation because they are do not pose a significant risk and which chemicals require further evaluation in the Baseline Ecological Risk Assessment. Chemicals which require further

evaluation are designated as Chemicals of Potential Ecological Concern. One objective of these sampling events is to collect data of sufficient quality from appropriate media to develop a SLERA. The risk management objective for this site is to protect aquatic communities in the Animas River from the deleterious effects of site related contamination. Significant amounts of analytical data are available for surface water that are suitable for use in an ecological risk assessment. There are to our knowledge, no recent sediment data from the Animas River so this data will be collected.

*Principle Study Question 4: What are the effects of various remediation scenarios on water quality in the Animas River?*

In order to determine the most efficient remedial actions for protection of the aquatic community in the Animas River, a tool to predict resultant water quality in the Animas is necessary. Calibration of the OTEQ model using new and existing data will provide this tool.

#### **4.3 Identify Information Inputs**

The purpose of this step is to identify the data required to answer the PSQs listed in section 4.2. The primary information and decision inputs will be data generated from field instruments and laboratory analyses, as well as water quality standards for comparison.

Field parameters and non-sampling objectives include:

- Taking temperature, pH, specific conductivity, dissolved oxygen (DO), and flow measurements or estimates
- Conductivity transects across Animas River at A68 and A72
- Equal discharge increment (EDI) technique water sampling following protocol described in the Operators Manual for the US DH-81 Depth Integrating Suspended Sediment Sampler for all stations in the Animas River.
- Photographing the sampling locations and other notable observations.

Analytical laboratory parameters for routine and opportunity aqueous samples and sediment samples will include:

- Total and dissolved Target Analyte List (TAL) metals and hardness (calculated).
- Total recoverable metals and mercury for sediment samples only
- Analysis of alkalinity and anions for all surface water samples
- Analysis for select stable isotopes



- Laboratory method detection limits will be below selected standards and applicable benchmarks.

The following factors will be evaluated in the overall decision-making process:

- Comparison of analytical data to applicable standards/benchmarks/water quality criteria: TMDLs, Segment-specific Water Quality Standards, and Colorado Table Value Standards;
- Sediment analytical results will be compared to threshold effect concentrations as described in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et al., 2000).
- Comparison of analytical data to applicable historical data to evaluate changes in water chemistry and metals loading over time.

#### **4.4 Define the Boundaries to the Study**

The objective of this step is to define the spatial and temporal components of the study area. The scale of the decision making for the DS is defined by combining the population of interest with the spatial and temporal boundaries. Practical constraints that could interfere with sampling are also identified. Implementing this step helps ensure that the data are representative of the population.

##### **4.4.1 Spatial Boundaries**

The study area boundary comprises the Animas River from up to 20 miles below compliance point A72 upstream to the upper Cement Creek drainage. Exact stations locations below A72 will be determined in the field and GPS coordinates will be collected. Sources include mining-impacted discharges from inactive or abandoned mines within approximately two miles of the historic Gladstone town site. These are the Gold King 7 Level, the American Tunnel, and the Red & Bonita, Mogul, and Grand Mogul mines. If seeps or springs are identified that contribute to flows into and out of the Cement Creek drainage, they may also be sampled.

##### **4.4.2 Temporal Boundaries**

These sources will be sampled during the approximate high and low flow regimes, depending on access and weather conditions. However, capturing representative high flow and low flow conditions will be the primary objective. High flow is generally during the May and June months and low flow conditions are typically during October through April. The ARSG would like to collect at least two years of data to help answer the study questions outlined above.

#### **4.5 Develop the Analytic Approach**

Total recoverable metals results and stream discharge measurements will be used to calculate loading of site related contaminants from contributing sources. The results from each of the inputs will be summed to determine the total loading of site related contaminants in Cement Creek into the Upper Animas River. Concentrations of metals in surface water will be compared to applicable standards/benchmarks/water quality criteria: TMDLs, Segment-specific Water Quality Standards, and Colorado Table Value Standards. Concentrations of metals in sediments will be compared to Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems (MacDonald et al, 2000). All analytical results will have detection limits suitable for comparison to these benchmarks and standards.

#### **4.6 Specify Performance or Acceptance Criteria**

The purpose of this step is to specify the tolerable limits on decision errors, which are used to establish performance goals for the data collection design. For this project, the number of samples and station locations are based largely on past investigations performed in 2009, 2010, and 2011.

In order to mitigate the potential for false positive and/or false negative errors associated with field sampling, sample collection processes will be consistent with established and relevant Standard Operating Procedures (SOPs). This includes collection of duplicate samples (and subsequent analysis using relative percent difference (RPD) statistics), implementing a decontamination procedure (which may include the use of disposable sampling equipment), and the use of field blanks. For laboratory analysis of samples, quality assurance/quality control (QA/QC) steps (such as the use of laboratory controls, matrix spikes, matrix spike duplicates, blanks, etc.) will be consistent with ESAT Region 8 reporting requirements.

#### **4.7 Plan for Collecting the Data**

A judgmental sampling design as described in *Guidance for Choosing a Sampling Design for Environmental Data Collection*, December 2002 (EPA QA/G-5S) will be used to assist with identification and verification of the sources of COPC. Sampling locations were identified from the historical sampling locations and stations were refined in 2012 to bracket mine influences from the Gold King 7 Level, the American Tunnel, the Red & Bonita, Mogul, and Grand Mogul mine sites. Data collected from this event will assist with identifying the order and magnitude of contamination reaching the Upper Animas River. Specific parameters of interest for the sampling events will follow the criteria listed in Section 4.2 and are describe in Table 4.3-1 and Table 4.3-2. Analysis methods for the events are described in Section 10.0 and management of the data is described in Section 15.0 of this document.

## **5.0 Sampling Locations**

The specific parameters of interest and station locations were based on results from the previous sampling events that took place during 2009 through 2011. Sampling locations, descriptions, and activities that will take place in 2012 are listed in Tables 4.3-1 and 4.3-2 and shown in Figures 5.0-1 and 5.0-2. Table 5.0-1 shows the GPS coordinates for each of the sampling locations. Sampling locations will be verified to the sub meter using Trimble GPS hand held devices.

A brief description of the sampling locations will be recorded in the field notebook for each site sampled. Information will consist of sampling location identification number, date, time, access information, geographical observations, and any other pertinent information that will be useful in identifying the sampling location in the future.

## **6.0 Sample Designation and Labeling**

Sample designation will consist of a series of letters and numbers to indicate site and location. Tables 4.3-1 and 4.3-2 show the naming convention used and the site descriptions. The sampling areas are as follows:

- A Animas River
- M Mineral Creek
- CC Cement Creek
- QA Queen Ann
- MTD Mogul Tailings Drainage
- FD Fenn Drainage
- ATS American Tunnel Seep

## **7.0 Surface Water**

The following sections describe the sampling methods that will be used for surface water sample collection. Copies of the applicable SOPs that outline how field activities will be performed (including critical documentation protocols) are located at the EPA Region 8 Laboratory and are included in Appendix A. The sampling checklist and field equipment checklist are shown in Tables 7.0-1 and 7.0-2, respectively.

### **7.1 Surface Water Sampling Protocol**

In order to address the objectives identified in the DQO process, surface water quality will be evaluated based on data collected from field measurements as well as laboratory analysis for the contaminants of concern and additional chemicals.

Wherever possible, water quality samples and flow measurements will be taken at locations such that significant in-flow metal contributions can be identified. Water quality samples and stream flow data will be used to characterize the concentrations, loads, and seasonal distribution of metals throughout the stream segment.

Sampling will progress from downstream to upstream locations to eliminate sediment disturbance in subsequent samples and minimize the potential for cross contamination. Surface water samples will be collected by immersing the sample bottle several inches beneath the water surface with the mouth of the sample bottle facing upstream. To collect such a sample, the sample container will be inverted, lowered to the approximate sample depth and held at about a 45-degree angle with the mouth of the bottle facing downstream.

If surface water samples cannot be collected directly into the sample container, a decontaminated 1-liter bottle will be used to collect the sample. The bottle will be rinsed three times in the water to be sampled prior to collecting the sample. Care will be taken to avoid excessive agitation when transferring samples to the sample containers.

For water samples in the Animas River, equal discharge increment technique (EDI) will occur during the low flow event and will require protocols specified in the “*Operators Manual for the US DH-81 Depth-Integrated Suspended-Sediment Sampler*” (FISP, No date). This technique will be employed during the low flow event at all locations warranted for the technique to be used. It will be at the discretion of the field team lead to determine if the sampling location is suitable to perform this type of sampling using the DH-81. This process of using the EDI technique will provide an equal volume of sample at each stream vertical from the cross section of the stream/river. Attachment A shows the filling time for the US DH-81 sampler using a 1 liter bottle and this is used to calculate the transit rate. The transit rate is determined by multiplying the stream depth at the sampling vertical by 2 and divide by the sampling time after determining the velocity of the stream. The result is the rate in ft/sec (FISP, No date). Table 7.1-1 shows the filling time for the DH-81 sampler using a 1 liter bottle.

Opportunistic stations will be used to better understand the mixing zone of Cement Creek in the Animas River. This will be accomplished by establishing a transect line across the Animas River and dividing the transect line into 5 equally spaced points and conductivity measurements will be collected at each point. The opportunistic samples will occur along locations in the Animas River and will be collected at ½ mile increments to Elk Creek and potentially downstream 20 miles towards the town of Durango. At each of the points, a composite water sample will be collected for each of the constituents listed in Table 4.3-2 and conductivity measurements will be collected at each point across

the transect. A single flow measurement will be collected after all samples have been collected.

Measures will be taken to minimize the amount of in-field equipment decontamination required for the sampling event. Reused sampling equipment will be decontaminated prior to the sample event. Decontamination will be achieved by washing with an acid rinse and triple rinsing with de-ionized water. Field equipment will be decontaminated by triple rinsing in the field with the exception of the flow meters and water quality meters.

#### **7.1.1 Dissolved Metals Fraction**

Water samples for dissolved metals analysis will be field filtered with a 0.45 micron filter into the sample container and then preserved at a pH of 2 with nitric acid after sample collection in the field. Water samples for total metals analysis will not be filtered, but will be preserved at a pH of 2 with nitric acid after sample collection in the field. Holding times for acidified samples will not exceed 6 months, whereas raw water samples are to be held no longer than 28 days before analysis.

Filtration will be done in accordance with the *Sample Preservation SOP # 3 FLD-03* (ESAT, 2011) which follows standard operating procedures for the filtration of water samples.

#### **7.1.2 Total Recoverable Metals Fraction**

Water samples for total recoverable metals will be collected in the sample container of which the sample will be sent to the laboratory for analysis and collection of samples will follow protocol described in *Surface Water Sampling SOP # FLD-01* (ESAT, 2011). Samples will be collected approximately at the same time as the dissolved metals fraction and the sample bottle will be triple rinsed with site water. After the rinsing procedure is completed, the sample will be collected and preserved in the field. After preservation, samples will be labeled and the chain of custody filled out in accordance with *Sample Custody and Labeling SOP # FLD-11* (ESAT, 2011) and placed in a cooler with ice.

#### **7.1.3 Alkalinity and Anions Fraction**

Water samples for anions will be collected at locations with pH greater than 4.5. It is anticipated that the Region 8 ESAT analytical team will be doing the analysis for alkalinity and anion samples and will follow EPA Method 310.1. A minimum of 250 mL of water is required for analysis. Sample collection will follow protocol described in *Surface Water Sampling SOP # FLD-01* (ESAT, 2011).

#### **7.1.4 Stable Isotope and Tritium Fraction**

Stable isotope water samples will be collected in two certified clean 60 mL borosilicate glass vials with air tight caps. Do not pre rinse sample bottles prior to collection and samples will be collected in a similar fashion as described in *Surface Water Sampling* SOP # FLD-01 (ESAT, 2011). Immediately after collection samples will be placed in a cooler with ice and maintained at a temperature of  $<6^{\circ}\text{C}$ .

Samples for tritium analysis will be collected in certified clean 1 liter high density polyethylene bottles. Sample bottles must not be rinsed prior to sample collection and samples will follow protocol described in *Surface Water Sampling* SOP # FLD-01 (ESAT, 2011).

### **7.2 Surface Water Field Measurements**

During sampling events, the following water quality parameters will be measured on a real-time basis in the field:

- pH
- Conductivity
- Temperature
- Dissolved Oxygen

Field measurements will be taken for each of the surface water sampling locations using an In-Situ water quality meter. All field water quality measurements will be recorded in a field notebook. Field measurements will be recorded during the time of sample collection and in-situ when possible. In the event that measurements cannot be made real-time or in-situ, a sample should be collected and analyzed as soon as possible using the Multiprobe sample cup. In this situation, temperature and dissolved oxygen measurements will be recorded in the field notebook with a notation indicating that the sample cup was used.

### **7.3 Surface Water Analytical Measurements**

Surface water samples collected will be submitted for analysis to the EPA Region 8 Laboratory, ESAT Analytical Chemistry department. Specific analysis for each event is presented in Tables 4.3-1 and 4.3-2. Samples will be collected, preserved, labeled, and stored in accordance with the *Field Sampling Protocols*, SOP # FLD 12. The sample protocols for surface water are provided in Table 7.3-1.

## **8.0 Sediment**

Sediment samples will be collected during the May and October sampling event at the locations listed in Tables 4.3-1 and 4.3-2 for determination of contaminant loading in streambed sediments. Samples will be analyzed for total recoverable metals and mercury. Method detection limits and methods are shown in Table 8.0-1. Sediment samples will be collected using Teflon scoops in accordance with the protocols outlined in *Standard Operating Procedures for Shallow Stream Sediment Sampling*, FLD-06 ESAT Region 8, (Appendix A).

## **9.0 Stream Flows**

Stream flow will be measured for surface water sampling locations provided conditions are deemed safe (based on observed stream conditions). Flow will be measured using a flow meter or prefabricated flumes following the protocols outlined in the *Flow Tracker Operation*, SOP # FLD 08. Flow measurement data will be recorded on a Stream Discharge Form. Flumes may be necessary to establish flows for low discharge streams. In the event that an established stream flow gage is present at the sampling location, stream flow data may be collected from the gage rather than using the flow meter. If this method is used, the gauge type and stream depth will be recorded in the field notebook.

## **10.0 Sample Analysis and Methods**

Samples will be analyzed for total recoverable metals, dissolved metals, hardness (calculated from dissolved metals), alkalinity, and anions. Table 7.3-1 includes the laboratory analytical instrumentation and methods to be used for sample analysis. These methods will be in accordance with EPA *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, also known as SW-846, Method 7473, Revision 0, January 1998. Additionally, sample analysis will be in accordance with Method 200.7 *Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry*, Revision 4.4, May 1994, and Method 200.8 *Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry*, Revision 5.4, May 1994 and Method 245.1, Revision 3.0 *Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectrometry*.

Sample disposal of potentially hazardous waste will follow protocol defined in *Collection, Analysis and Disposal of ESAT Laboratory Waste* SOP LAB01.01 (ESAT, 2012).

Field parameters measured at each sample site will include dissolved oxygen, temperature, pH, conductivity, and stream flow (as described in Section 3.0). Physical observations of the stream will be noted in the field notebook. Photographs of the site will be taken and will be documented as an appendix to the 2012 Sampling Activities Report.

In the event problems are encountered in the field that impact the implementation of this SAP/QAPP, the EPA RPM, or his/her designee will be responsible for directing corrective actions. The designee appointed for the studies is Dan Wall. Any problems encountered and actions taken or deviations from this SAP will be documented in the field notebook.

It is currently anticipated that ESAT will be used for sample analysis during this project. Laboratory instrumentation and method requirements for the ESAT laboratory are included in Table 7.3-1.

### **11.0 Quality Control**

Laboratory QC criteria for ESAT and EPA Region 8 are included in Table 10.0-1 and calculations used for generating QA/QC parameters are included in Table 10.0-2. The sample selection for laboratory QC will be determined by the laboratory staff. Where a specific QC criteria table is not provided, the method's QC requirements are met or exceeded by ESAT's and EPA's analytical process.

The calibration procedures for the field measurements to be performed using the In-Situ water quality meter are detailed in the *Water Quality Measurements with the In-Situ® Multi-Parameter Meter* SOP # FLD-09. If other multi-probes are used for this sampling event, the field sampling team will calibrate the probe according to the manufacturers specifications listed in the owner's manual. The SOPs and procedures appended to this document also detail the associated QA and/or QC criteria for the field analyses and equipment.

Field QC samples will be collected on the following basis:

- Filter/container/preservative blank – minimum of 1 blank per 20 samples collected or 1 field blank per day
- Duplicates (collocated) – minimum of 1 duplicate per 20 samples collected

### **12.0 Inspection/Acceptance of Supplies and Consumables**

All supplies for this event will be purchased by the EPA from approved vendors, and stored in the field sampling room (or adjacent storage rooms at the Region 8 Laboratory). The week prior to the sampling event, an EPA or ESAT sampling team member will gather needed supplies and consumables, which will subsequently be verified by an ESAT team member. Supplies and consumables will be ordered, inspected upon receipt, accepted, tracked, and inventoried by the EPA field biologist at the Region 8 Laboratory. Acceptance of supplies and consumables will be based on the requirements of the end user.



### **13.0 Special Training and Certifications**

All field staff have completed the Occupational Safety and Health Administration (OSHA) 40-hour Health and Safety Course for Hazardous Waste Site Worker Training in accordance with Sections e and p of OSHA 29 Code of Federal Regulation (CFR) 1910.120 and maintain this certification with annual eight-hour Hazardous Waste Site Operations Refresher Training as required by Sections e and q of OSHA 29 CFR 1910.120. Field staff has completed American Red Cross Standard First Aid and Adult CPR Training and maintain this certification annually for Adult CPR and every two years for Standard First Aid. The ESAT and EPA Health and Safety Managers are responsible for ensuring that all field staff completes the training requirements as required by OSHA.

### **14.0 Non-Direct Measurements**

Non-direct measurements were relied upon for preparation of project implementation. These measurements include previous sampling and analysis plans (EPA, 2009) and historical data reports.

### **15.0 Assessments and Response Actions**

Assessment and oversight of field sampling activities and implementation of the SAP/QAPP will include the following:

- Oversight of field sampling activities
- Oversight of sample handling and chain of custody procedures

The following individuals or their designees are authorized to perform any of the assessments listed above:

- EPA Task Order Project Officer- Dan Wall
- EPA Remedial Project Manager – Michael Holmes

Assessment of field activities may occur at any time and without prior notice. Only authorized individuals may conduct the assessments and it is their role to issue any corrective action or response action to the situation. If minor problems are identified they will be addressed on site prior to resuming work. If more significant problems are identified then a stop work order can be issued by the Task Order Project Officer until the project manager or designee can resolve the problem.

### **16.0 Data Management**

All field measurements and observations will be recorded in a bound notebook or on appropriate data sheets by the field personnel at the time they are performed. The personnel doing the recording will initial and date all measurements, observations, and any other notations made. Corrections will be performed by drawing a single line

through the error accompanied by the date and the initials of the person performing the correction, followed by the proper entry.

Samples will be logged into a Laboratory Information Management System (LIMS) upon receipt at the laboratory by an analytical chemist and all analytical data will be entered into the Scribe database for permanent storage/archiving.

Peer review of the data package, at a 100% frequency of reported versus raw data, will be performed by the analytical laboratory prior to releasing a final report. The final report will be in a standard Contract Laboratory Program (CLP) format, including all laboratory and instrument QC results.

### **17.0 Reporting**

The laboratory will submit to EPA a data report containing analytical results for surface water this sampling event. The data report will contain a case narrative that briefly describes the number of samples, analyses, and any analytical difficulties or QA/QC issues associated with the samples. The data report will also include signed chain-of-custody forms, analytical data, a QA/QC package, and raw data. Additional reporting requirements are outlined in the ESAT laboratory contract.

### **18.0 Data Validation and Usability**

Laboratory data validation and verification will begin at the sample log-in stage where a sample log-in technician or chemist will compare received samples against chain-of-custody forms and document sample condition (damage, temperature, etc.). Validation and verification of data will be performed by QA/QC personnel following USEPA National Functional Guidance for Inorganic Data, (EPA, 2002) in order to determine if the DQOs were met. Sample data deemed outside the expected range will be investigated, communicated to the analytical chemistry staff, flagged (if needed) and potentially re-sampled to verify or discredit the data. Data that have proven to be incorrect may be flagged, further reviewed, or invalidated. The cause of incorrect data will be investigated and appropriate response actions will be taken, including communication of any issues to the user in the data report.

Uncertainty of validated data will be evaluated by the RPM to determine if the DQOs were met. In the event that the DQOs were not met, they will be reviewed to determine if they are achievable and may be revised if necessary, and the data may be further evaluated to determine the impact to the project. Data usability and limitations will be evaluated by the RPM.

### **18.1 Abbreviated Data Verification**

Abbreviated verification will be completed on 10% of the analytical results for data that is electronically uploaded directly from the analytical instrumentation into the ESAT LIMS. This will be performed to ensure that data were produced in accordance with procedures outlined in this project plan. The following elements will be reviewed for compliance as part of the abbreviated data validation:

- Holding Times
- Calibration
- Blanks
- Spikes
- Duplicates
- Laboratory Control Spikes (LCSs)
- Reporting Limits
- Analyte Quantification

### **18.2 Data Validation**

The analytical data will be validated for 10% of the results by either the acting EPA Region 8 Laboratory QA Officer or by a designated TechLaw, Inc. Quality Assurance officer outside of the Region 8 ESAT office. The validation will include reviewing 10% of the samples for 100% of the analytical analysis performed and reported. The following elements will be reviewed for compliance as part of the abbreviated data validation:

1. Holding Times
2. Calibration
3. Blanks
4. Spikes
5. Duplicates
6. LCSs
7. MS/MSD
8. Post Digest Spike
9. Internal Control Standard
10. Dilution Sample
11. Reporting Limits
12. Analyte Identification
13. Analyte Quantification
14. Comparison of hardcopy results to EDD

Data validation will conform to the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic data and will use standard data qualifiers as described below.

### **Data Qualifier Definitions**

The following definitions provide brief explanations of the national qualifiers assigned to results in the data review process. If the regions choose to use additional qualifiers, a complete explanation of those qualifiers should accompany the data review.

U	The analyte was analyzed for, but was not detected above the level of the reported sample Quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the results may be biased high.
J-	The result is an estimated quantity, but the results may be biased low.
R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting Quality Control (QC) criteria. The analyte may or may not be presented in the sample.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

### 18.3 Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity

The documentation of the data evaluation effort will be in the form of the work sheets prepared during validation. These worksheets will be an appendix to the Data Summary Report (DSR). The DSR will be prepared to identify problems that may affect data usability or require that the data be qualified. The DSR report will discuss all Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity (PARCCS) parameter results from the data validation and overall usability of the data for project objectives, include the following:

#### Precision:

- Field Duplicates: RPD criteria met?
- Laboratory Duplicates: RPD criteria met?
- Method of standard dilution performed and criteria met?
- Matrix Spike Duplicates: RPD criteria met? (If applicable)

#### Accuracy:

- Matrix Spike/Matrix Spike Duplicates: %R (recovery) criteria met?
- Laboratory Control Sample/Laboratory Control Sample Duplicates: %R criteria met?
- Initial and Continuing Calibration Recoveries met?
- Interference Check Sample Recoveries met?
- Inductively Coupled Plasma Serial Dilution Recoveries met?

#### Representativeness:

- Sampling Procedures and Design: Criteria met?
- Holding Times and Preservation: Criteria met?
- Custody: All chain-of-custody forms complete and provided in data package?

- Blanks: Contaminants present?

Completeness:

- The number of valid analytical results are comparable (90%) with the number determine necessary during establishment of DQOs.

Comparability:

- Data compares with similar analysis and data sets?
- Sample collection methods comparable to similar data sets?
- Laboratory analytical methods comparable to similar data sets?

Sensitivity:

Method reporting limits met project objectives?

## **19.0 Reconciliation with DQOs**

Information obtained from the field investigation will be evaluated through the Data Quality Assessment (DQA) process to determine if the data obtained are of adequate quality and quantity to support their intended use. The DQA process consists of five steps, as summarized below (USEPA, 2006):

- 1.) *Review the project's objectives and sampling design:* Review the objectives defined during the systematic planning to assure that they are still applicable. If objectives have not been deployed, specify them before evaluating the data for the projects objectives. Review the sampling design and data collection documentation for consistency with the project objectives observing any potential discrepancies.
- 2.) *Conduct a preliminary data review:* Review QA reports (when possible) for the validation of data, calculate basic statistics, and generate graphs of the data. Use this information to learn about the structures of the data and identify patterns, relationships, or potential anomalies.
- 3.) *Select the statistical method:* Select the appropriate procedures for summarizing and analyzing the data based on the review of the performance and acceptance criteria associated with the project objectives, the sampling design, and the preliminary data review. Identify the key underlying assumptions associated with the statistical tests.
- 4.) *Verify the assumptions of the statistical method:* Evaluate whether the underlying assumptions hold, or whether departures are acceptable, given the actual data and other information about the study.

5.) *Draw conclusion from the data:* Perform the calculations necessary to draw reasonable conclusions from the data. If the design is to be used again, evaluate the performance of the sampling design.

Uncertainty of validated data will be evaluated by the RPM to determine if the DQOs were met. In the event that the DQOs were not met, they will be reviewed to determine if they are achievable and may be revised if necessary, and the data may be further evaluated to determine the impact to the project. Data usability and limitations will be evaluated by the RPM.

## **20.0 References**

### **Documents:**

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U.S. Environmental Protection Agency (EPA). 2001a. "EPA Requirements for Quality Assurance Project Plans" EPA QA/R-5. March 2001.

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## **Tables**



Table 4.3-1  
Upper Animas  
Sampling Locations and Activities – May 2012

			Stream Measurements		Surface Water Collection				Sediment
	Station Location	Site Description	Temperature, Dissolved Oxygen, pH, and Conductivity	Stream Flows or gage reading	Total Recoverable Metals (Nitric)	Dissolved Metals (Nitric)	Anions (Ice)	Stable Isotope ( <sup>18</sup> O/D) Ice	Total Recoverable Metals
Animas River	A68	14th Street Gauge @ 13th Street Bridge	1	1	1	1	1		1*
	A72	Animas Gauge below Silverton	1	1	1	1	1		1*
Mineral Creek			1	1	1	1	1		
	M34	Mineral Creek Gauge							
Cement Creek	CC01F	CC above Grand Mogul, blw waterfall	1	1	1	1	1	1	
	CC01U	CC downstream of Sublevel 1drainages	1	1	1	1	1		
	CC03B	Cement Creek immediately upstream of Red and Bonita confluence. Site is straight across from a power pole. New site for June 2010. Site was named CCOPP-12 during sampling events previous to November 2010.	1	1	1	1	1		
		Cement Creek downstream of the Red and Bonita confluence and upstream of the North Fork confluence. Access site just upstream of the road crossing at the North Fork. New site for June 2010. Site was called CCOPP-11 in sampling events previous to November 2010.	1	1	1	1	1		
	CC18B	CC abv. Amer. Tunnel confluence,2009	1	1	1	1	1		
	CC18	CC above treatment plant	1	1	1	1	1		
	CC21	CC below SF	1	1	1	1	1		
	CC21B	CC ups of Prospect Gulch and dws of Dry Gulch. Is CC21 different?	1	1	1	1	1		
	CC41	CC ups of Illinois Gulch and dws of Ohio Gulch	1	1	1	1	1		
	CC48	Cement Creek upstream from Animas	1	1	1	1	1		
	Cement Creek Tributaries	CC01C1	Grand Mogul north seep(stream right)	1	1	1	1	1	1
CC01C		Grand Mogul	1	1	1	1	1	1	
CC01C2		Grand Mogul consolidated discharges	1	1	1	1	1		
CC02D		Mogul	1	1	1	1	1	1	
CC02E		Gold Point	1	1	1	1	1		
CC02K		Pride of Bonita	1	1	1	1	1		
MTD-4		Mogul tailings drainage just upstream of confluence with Cement Creek. Site is upstream along Cemen	1	1	1	1	1		
FD-1		Fenn drainage upstream of confluence with Cement Creek. Site is near MTD-4 but downstream along Cement Creek.	1	1	1	1	1		
CC03D		Red & Bonita @culvert	1	1	1	1	1		
CC03C		Red & Bonita at outflow from mine tunnel.	1	1	1	1	1	1	
CC07		NF Cement@rd crossing	1	1	1	1	1		
CC19		American Tunnel	1	1	1	1	1	1	
CC14		Silver Ledge	1	1	1	1	1		
CC15		SF above Silver Ledge	1	1	1	1	1		
CC16B		SF Below Silver Ledge	1	1	1	1	1		
CC17		SF above CC	1	1	1	1	1		
CC26		Prospect Gulch Mouth	1	1	1	1	1		
CC40		Ohio Gulch mouth above Cement Creek	1	1	1	1	1		
CC42	Illinois Gulch	1	1	1	1	1			
North Fork Cement Creek	CC04	NF CC above Gold King	1	1	1	1	1	1	
	CC07	NF Cement@rd crossing	1	1	1	1	1		
North Fork Cement Creek Tributaries	CC06	Gold King 7 level	1	1	1	1	1	1	
	CC06B	Second portal at the Gold King 7-Level mine. Site has considerably less flow than CC06 and is right beside a power pole. First sampled in Aug.2011	1	1	1	1	1		
Cement Creek	USCC02D	Located on Cement Creek below CC01C1 and above the Mogul mine	1*	1*	1*	1*	1*	1	
	UASW020	Located on Cement Creek below the Mogul mine	1*	1*	1*	1*	1*	1	
Upper Animas Mixing Zone Opp Samples	Opp Sample 1	Upstream of Compliance Station Animas River (River Right)	1*	1*	1*	1*	1*		1*
	Opp Sample 2	Upstream of Compliance Station Animas River (Right Center)	1*		1*	1*	1*		
	Opp Sample 3	Upstream of Compliance Station Animas River (Center)	1*		1*	1*	1*		
	Opp Sample 4	Upstream of Compliance Station Animas River (Left Center)	1*		1*	1*	1*		
	Opp Sample 5	Upstream of Compliance Station Animas River (River Left)	1*		1*	1*	1*		
	Opp Sample 6	Downstream of Compliance Station Animas River (River Right)	1*	1*	1*	1*	1*		1*
	Opp Sample 7	Downstream of Compliance Station Animas River (River Center)	1*		1*	1*	1*		
	Opp Sample 8	Downstream of Compliance Station Animas River (Center)	1*		1*	1*	1*		
	Opp Sample 9	Downstream of Compliance Station Animas River (River Left Center)	1*		1*	1*	1*		
	Opp Sample 10	Downstream of Compliance Station Animas (River Right)	1*		1*	1*	1*		
		Total Number of Samples	49	49	49	49	49	10	4

Note:One duplicate sample will be collected for every 10 samples collected (10% frequency)

Field blank needed for each day of collection

\* Indicates that sample is to be collected deemed conditions are safe and based on the judgement of the field sampling team

Table 4.3-2  
Upper Animas  
Sampling Locations and Activities – October 2012

	Station Location	Site Description	Stream Measurements		Surface Water Collection					Sediment
			Temperature, Dissolved Oxygen, pH, and Conductivity	Stream Flows or gage reading	Total Recoverable Metals (Nitric)	Dissolved Metals (Nitric)	Anions (Ice)	Alkalinity	Stable Isotope ( <sup>18</sup> O/D) Ice	Total Recoverable Metals
Animas River	A56	Animas above Arastra & Mill Overflow pipe (Lat 37.8278 Lon -107.6242)	1	1	1	1	1	1		1*
	A58	Arastra @ confluence (Lat 37.8258 Lon -107.6242)	1	1	1	1	1	1		1*
	A68	14th Street Gauge @ 13th Street Bridge	1	1	1	1	1	1		1*
	A69A	Animas River upstream of Idaho Gulch	1	1	1	1	1	1	1	
	A70B	Animas River upstream of Mineral Creek	1	1	1	1	1	1		
	A71B	Animas River downstream of Mineral Creek	1	1	1	1	1	1		
	A72	Animas Gauge below Silverton	1	1	1	1	1	1		1*
	A73D	Animas upstream of Molas Creek	1	1	1	1	1	1		1*
	A73C	Animas downstream of Molas Creek	1	1	1	1	1	1		1*
	A73MC	Molas Creek @ confluence with Animas	1	1	1	1	1	1		1*
	A75D	Animas upstream of Cascade Creek	1	1	1	1	1	1		1*
	A75B	Animas downstream of Cascade Creek	1	1	1	1	1	1		1*
	A75CC	Cascade Creek @ confluence with Animas	1	1	1	1	1	1		1*
Mineral Creek			1	1	1	1	1	1		
	M34	Mineral Creek Gauge								
Cement Creek	CC01F	CC above Grand Mogul, blw waterfall	1	1	1	1	1	1	1	
	CC01U	CC downstream of Sublevel 1 drainages	1	1	1	1	1	1		
	CC01T	CC downstream of Queen Anne	1	1	1	1	1	1		
	CC02H	CC above road to Mogul	1	1	1	1	1	1		
	CC03B	Cement Creek immediately upstream of Red and Bonita confluence. Site is straight across from a power pole. New site for June 2010. Site was named CCOPP-12 during sampling events previous to November 2010.	1	1	1	1	1	1		
	CC03	Cement Creek downstream of the Red and Bonita confluence and upstream of the North Fork confluence. Access site just upstream of the road crossing at the North Fork. New site for June 2010. Site was called CCOPP-11 in sampling events previous to November 2010.	1	1	1	1	1	1		
	CC03A	CC below FD-1	1	1	1	1	1	1		
	CC03E	Red and Bonita Inflow	1	1	1	1	1	1		
	CC18B	CC above American Tunnel confluence	1	1	1	1	1	1		
	CC18	CC above treatment plant	1	1	1	1	1	1		
	CC21	CC below SF	1	1	1	1	1	1		
	CC21B	CC ups of Prospect Gulch and dws of Dry Gulch	1	1	1	1	1	1		
	CC41	CC ups of Illinois Gulch and dws of Ohio Gulch	1	1	1	1	1	1		
	CC44B	CC upstream from Topeka Gulch	1	1	1	1	1	1		
	CC45K	CC upstream of Niagara Gulch	1	1	1	1	1	1		
	CC46B	CC downsteram from Hancock Gulch	1	1	1	1	1	1		
	CC47C	CC upstream of Soda Gulch	1	1	1	1	1	1		
	CC48	Cement Creek upstream from Animas	1	1	1	1	1	1		
	CC01H	Located on Cement Creek below CC01C1 and above the Mogul mine	1	1	1	1	1	1	1	
	CC02B	Located on Cement Creek below the Mogul mine	1	1	1	1	1	1	1	
	CC01H	Located on Cement Creek below CC01C1 and above the Mogul mine	1	1	1	1	1	1	1	
	CC02B	Located on Cement Creek below the Mogul mine	1	1	1	1	1	1	1	
	CC49	Cement Creek at mouth	1	1	1	1	1	1		
Cement Creek Tributaries	CC01C1	Grand Mogul north seep (stream right)	1	1	1	1	1	1	1	
	CC01C	Grand Mogul	1	1	1	1	1	1	1	
	CC01C2	Grand Mogul consolidated discharges	1	1	1	1	1	1		
	CC02D	Mogul	1	1	1	1	1	1	1	
	CC02E	Gold Point	1	1	1	1	1	1		
	CC02K	Pride of Bonita	1	1	1	1	1	1		
	MTD-4	Mogul tailings drainage just upstream of confluence with Cement Creek	1	1	1	1	1	1		
	FD-1	Fenn drainage upstream of confluence with Cement Creek. Site is near MTD-4 but downstream along Cement Creek.	1	1	1	1	1	1		
	ATS-1	American Tunnel Seep #1	1	1	1	1	1	1		
	CC03D	Red & Bonita @ culvert	1	1	1	1	1	1		
	CC03C	Red & Bonita at outflow from mine tunnel	1	1	1	1	1	1	1	
	CC19	American Tunnel	1	1	1	1	1	1	1	
	CC19C	American Tunnel at Cement Creek Inflow	1	1	1	1	1	1		
	CC14	Silver Ledge	1	1	1	1	1	1		
	CC15	SF above Silver Ledge	1	1	1	1	1	1		
	CC16B	SF Below Silver Ledge	1	1	1	1	1	1		
	CC17	SF above CC	1	1	1	1	1	1		
	CC26	Prospect Gulch Mouth	1	1	1	1	1	1		
	CC28C	CC upstream of Tiger Gulch	1	1	1	1	1	1		
	CC30N	CC upstream of Fairview Gulch	1	1	1	1	1	1		
	CC34	CC upstream of Minnesota Gulch	1	1	1	1	1	1		
	CC40	Ohio Gulch mouth above Cement Creek	1	1	1	1	1	1		
	CC40B	Cement Creek upstream of Ohio Gulch	1	1	1	1	1	1		
	CC42	Illinois Gulch	1	1	1	1	1	1		
North Fork Cement Creek	CC04	NF CC above Gold King	1	1	1	1	1	1	1	
	CC07	NF Cement @ rd crossing	1	1	1	1	1	1		
	CC06	Gold King 7 level	1	1	1	1	1	1	1	
	CC06B	Second portal at the Gold King 7-Level mine. Site has considerably less flow than CC06 and is right beside a power pole. First sampled in Aug. 2011	1	1	1	1	1	1		
Total Number of Samples			65	65	65	65	65	65	13	10

Note: One duplicate sample will be collected for every 10 samples collected (10% frequency)  
Field blank needed for each day of collection  
\* Indicates that sample is to be collected deemed conditions are safe and based on the judgement of the field sampling team

OTEQ and EPA

OTEQ only

EPA Only

Conductivity transect to assess mixing

Table 5.0-1  
Upper Animas 2012  
Sampling Location Coordinates

	Station Location	Latitude	Longitude
Animas River	A68	37.8111	-107.6586
	A72	37.79027	-107.6676
Mineral Creek	M34	37.8028	-107.6722
Cement Creek	CC01F	37.909344	-107.6299
	CC01U	37.910742	-107.6349
	CC03B	37.89778	-107.646
	CC03	37.89554	-107.647
	CC18B	37.894229	-107.6473
	CC18	37.891272	-107.6492
	CC21	37.889465	-107.6542
	CC21B		
	CC41	37.8517	-107.6758
	CC48	37.82	-107.6631
Cement Creek Tributaries	CC01C1	37.90994	-107.631
	CC01C	37.9101	-107.6322
	CC01C2	37.910119	-107.6329
	CC02D	37.9098	-107.6384
	CC02E	37.90823	-107.6384
	CC02K	37.907497	-107.6402
	MTD-4	37.908761	-107.6418
	FD-1	37.908689	-107.6421
	CC03D	37.8968	-107.6449
	CC03C	37.8972	-107.6439
	CC07	37.8951	-107.6468
	CC19	37.890981	-107.6484
	CC14	37.5236	-107.3838
	CC15	37.8756	-107.6439
	CC16B		
	CC17	37.8894	-107.6506
	CC26		
	CC40	37.8522	-107.6781
	CC42	37.8506	-107.6758
North Fork Cement Creek	CC04	37.8944	-107.6328
	CC07	37.8951	-107.6468
North Fork Cement Creek Tributaries	CC06	37.8946	-107.6384
	CC06B	37.894731	-107.6386
Cement Creek	USCC02D		
	UASW020		

**Table 7.0-1 Sampling Checklist**

1. Make sure the necessary paperwork is in place for a field event: Approved LSR, SAP, and QAPP.
2. Coordinate sampling dates and times with members of the field team and talk with chemists involved in the project to see if your plans work for them. Coordinate sample delivery with outside laboratories.
3. Fill out the necessary paperwork: Comp Time forms and TAs if travel will be more than 50 miles from the laboratory. Be sure to have reservations made for airlines and hotels if necessary.
4. Make necessary arrangements with people outside of the Region VIII laboratory that are involved with the project. Arrange meeting times and places, vehicle needs, sampling teams, additional equipment needs, etc.
5. Inform any volunteers outside of the EPA laboratory group what will be involved with sampling - physical stressors, equipment to bring, lunch, water, etc.
6. Calibrate meters needed for fieldwork well-before leaving. Make sure:
  - a. pH probes are filled.
  - b. DO membranes are intact.
  - c. Spare batteries, calibration logs, and pens are available for each meter.
  - d. Replace pH and conductivity calibration standards with fresh solution.
  - e. Condition new probes and replace damaged ones as needed. Buy new equipment from a scientific vendor if necessary.
7. Lay out needed sampling equipment in the field room (see attached list).
8. Check vehicles: fill with gas, top off windshield wiper fluid, equip with cell phones, walkie-talkies, and chargers.
9. Charge batteries for needed sampling equipment one or two nights before leaving: digital camera, hydrolab, GPS units, walkie-talkies, etc.
10. Pack vehicles the night before leaving. In the event of hot or cold weather, leave meters and deionized water in the field room and pack the day you leave.
11. In the event of a day-trip, calibrate meters the morning you leave.

**Table 7.0-2 Field Equipment List**

**Sample Containers:**

250 ml HDPE containers  
Gallon cubitainers  
VOA vials  
Glass Amber (BNA, pest)  
1 oz plastic (sed. metals)

**Filter Apparatus:**

250 or 500 ml filters  
Filter Stands  
Vacuum pump with spare  
Prefilters  
Teflon Tweezers

**Preservatives:**

HNO<sub>3</sub> - metals  
H<sub>2</sub>SO<sub>4</sub> - nutrients  
Phosphoric - TOC/DOC  
HCl - VOAs (pipet)  
CaCO<sub>3</sub> Acid Waste  
Container  
Ice/Snow

**Paperwork:**

Flow forms with clipboard  
SAP / HSP  
Maps/Gazeteer  
Chains  
Tags  
Field Notebook(s)  
FedX Forms  
Pens  
Markers  
Custody Seals

**Meters (w/logs):**

Flow meter-  
Tape measure Wading rod  
D batteries  
Rebar  
Forms  
Calculator Stopwatch,  
bucket  
Flumes- bubble level,  
shovel  
GPS Units (charged)-  
Compass  
Distance meter  
Digital Camera w/batteries  
Multimeters (charged)-  
Cal standards  
Cap & cal. cup  
Membranes  
Fill solutions  
Control unit  
Sonde

Logbook  
Cables - long/short

**Misc:**

Battery charger  
pH test strips  
Latex gloves  
Neoprene gloves  
Safety glasses  
Kimwipes  
Trash bags  
Plastic Bags  
Tape  
Bucket  
Coolers  
DI rinse bottles  
Cell Phones w/ charger  
Walkie-Talkies w/batteries  
Shovel  
Spare car keys  
Vehicle log & credit card  
Govt. purchase card  
DI water for blanks  
DI rinse bottles

**Macroinvertebrate Samples:**

Sample containers  
D-Frame Dip Net  
Surber Sampler  
Sieve  
White Tray  
Rinse bottle  
Picking forceps/brush  
95% Ethanol preservative  
Bucket  
Orange water gloves

**Well Sampling:**

Solinst depth meter w/battery  
Grundfos well pump-  
Control unit  
Hose reel w/ pump  
Discharge tube  
Cooling sleeve  
Screw driver  
Wrenches  
Metric hex keys  
DI water  
3 to 2 prong electrical  
converter  
Generator- gas, ext. chord  
Well Bailors  
String or chord  
Long multimeter cable

**Summer Field Gear:**

Backpacks  
Hiking Boots  
Hat  
GorTex Waders  
Wading Boots  
Rain Parka  
Wool Socks  
Layered Clothing  
Sunscreen  
Chapstick  
Bug Spray  
Sun Glasses  
Water/Food  
Pocket Knife

**Winter Field Gear:**

Shovel/Ice Breaker  
Backpacks  
Snowshoes  
Hiking Poles  
Insulated Water Gloves  
Hat  
Gloves  
Balaclava  
Neoprene Waders  
Wading Boots  
Wool Socks  
Layered Clothing  
Sunscreen  
Chapstick  
Sunglasses  
Water/Food  
Pocket Knife

**Field Meters (when not using multimeters):**

logbooks  
pH- buffers  
probe solutions batteries  
DO- Spare membranes filling  
solution  
Barometer  
Calibration equip:  
Winkler Bottle  
Starch  
0.035N Na Thio  
Buret/Pipet  
Buret Holder  
Flask w/ stir bar  
Powder Pillows:  
MnSO<sub>4</sub>  
Alk Iodide-Azide  
Sulfamic Acid  
Conductivity-  
calibration stds

**Table 7.1-1****Filling Time for the DH-81 Sampler using a 1 liter Bottle**

Velocity, ft/sec	Volume, mL	3/16-in nozzle	1/4-in nozzle	5/16-in nozzle
1.4	800		59	
1.6	800		52	
1.8	800		46	
2.0	800	74	41	27
2.2	800	67	38	24
2.4	800	61	35	22
2.6	800	57	32	20
2.8	800	53	30	19
3.0	800	49	28	18
3.2	800	46	26	17
3.4	800	43	24	16
3.6	800	41	23	15
3.8	800	39	22	14
4.0	800	37	21	13
4.2	800	35	20	13
4.4	800	33	19	12
4.6	800	32	18	12
4.8	800	31	17	11
5.0	800	29	17	11
5.2	800	28	16	10
5.4	800	27	15	10
5.6	800	26	15	9
5.8	800	25	14	9
6.0	800	25	14	9
6.2	800	24	13	9
6.4	800		13	8
6.6	800		13	8
6.8	800		12	8
7.0	800		12	8
7.2	800		12	
7.4	800		11	
7.6	800		11	

**Table 7.3-1 Water  
QC Criteria**

Target Analytes	EPA Method <sup>1</sup>	Instrument	Fraction Evaluated	Sample Volume Req'd (ml)	Preservation	Holding Time	Laboratory MDL, ug/L	Laboratory PQL, ug/L	CDPHE Surface Water Regulations <sup>3</sup>	MCL <sup>4</sup>
Aluminum (Al)	200.7	ICP-OE	TR & Diss	Diss - 250ml TR - 500ml	HNO <sub>3</sub> to pH <2	180 days	20	50	750	-
Beryllium (Be)	200.7	ICP-OE	TR & Diss				2	5	-	4
Calcium (Ca)	200.7	ICP-OE	TR & Diss				100	250	NA	NA
Iron (Fe)	200.7	ICP-OE	TR & Diss				100	250	300 (WS)	300 (Diss only)
Chromium (Cr)	200.7	ICP-OE	TR & Diss				2	5	50 (TR)	100
Magnesium (Mg)	200.7	ICP-OE	TR & Diss				100	250	NA	NA
Manganese (Mn)	200.7	ICP-OE	TR & Diss				2	5	50 (WS)	50
Strontium (Sr)	200.7	ICP-OE	TR & Diss				2	10	NA	NA
Silica (SiO <sub>2</sub> )	200.7	ICP-OE	TR & Diss				250	1000	NA	NA
Zinc (Zn)	200.7	ICP-OE	TR & Diss				10	20	65	5000
Calculated Hardness	2340B <sup>2</sup>	Calculated from 200.7, Ca & Mg	TR & Diss	-			-	-	(50)	-
Antimony (Sb)	200.8	ICP-MS	TR & Diss	Diss - 250ml TR - 500ml		180 days	0.5	1	-	6
Arsenic (As)	200.8	ICP-MS	TR & Diss				0.5	2	50	50
Cadmium (Cd)	200.8	ICP-MS	TR & Diss				0.1	0.2	3.5	5
Copper (Cu)	200.8	ICP-MS	TR & Diss				0.5	1	7	1000
Lead (Pb)	200.8	ICP-MS	TR & Diss				0.1	0.2	1.2	50
Nickel (Ni)	200.8	ICP-MS	TR & Diss				0.5	1	29	100
Selenium (Se)	200.8	ICP-MS	TR & Diss				0.5	1	4.6	50
Silver (Ag)	200.8	ICP-MS	TR & Diss				0.2	0.5	0.1	100
Thallium (Tl)	200.8	ICP-MS	TR & Diss				0.1	0.2	15	500
Dissolved Organic Carbon	415.3	Combustion/Non-dispersive IR	Diss	250 ml	Phosphoric acid, pH<2	28 days	1 mg/L	1 mg/L	-	-
Alkalinity	310.1	Mettler AT	Total	250 ml	Cooled to 4°C +/- 2	14 days	5	5	NA	NA
Chloride	300.0 <sup>6</sup>	Ion Chromatography	Diss	250 ml	Cooled to 4°C +/- 2	28 days	1.0 mg/L	2.0 mg/L	250 mg/L	250 mg/L
Fluoride	300.0 <sup>6</sup>		Diss				0.1 mg/L	0.2 mg/L	2 mg/L	4 mg/L
Sulfate	300.0 <sup>6</sup>		Diss				2 mg/L	5 mg/L	250 mg/L	250 mg/L

Diss = Dissolved metals fraction, i.e. source water filtered through 0.45 um filter prior to preservation (acidified).

TR = Total recoverable metals, source water, acidified (preserved).

MDL: Method Detection Limit, statistically determined from the deviation in a series of seven low level (3-5x the anticipated MDL) analyses, treated exactly as unknown samples for analysis. 40 CFR Chapter 1, Part 136, Appendix B

PQL: Practical Quantitation Level. Target analyte concentrations between PQL and MDL qualified as estimated, 'J', due to potential high variability. 40 CFR Parts 9, 141 and 142 [WH-FRL-6934-9]

<sup>1</sup>EPA's *Methods for the Determination of Metals in Environmental Samples*, Supplement I, May 1994 (Series 200 Methods)

<sup>2</sup>*Standard Methods for the Examination of Water and Wastewater*, 18th Edition, 1992

<sup>3</sup> Colorado Department of Public Health and Environment Water Quality Control Commission, Regulation 31, *The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31)*, Effective March 22, 2005. Three different standards apply to the waters in th

<sup>4</sup> MCL: Maximum Contaminant Level, a concentration set by the above CDPHE publication, Table III, "Drinking Water Supply".

<sup>5</sup>EPA's *Test Methods for Determining Solid Waste*, SW-846

<sup>6</sup>EPA's *Methods for Chemical Analysis of Water and Wastes*, June 2003

<sup>7</sup>Water supply limits for organic chemicals taken from CDPHE EWQCC, Reg. 31. Lower value of given range is reported.

Target Analytes	EPA Digestion Method <sup>1</sup>	EPA Method <sup>1</sup>	Instrument	Fraction Evaluated	Sample Volume	Preservation	Holding Time	Laboratory PQL (mg/kg)	Sediment Screening Benchmark (mg/kg)
Aluminum (Al)	200.2	200.7	ICP-OE	TR	200 grams	Ice	180 days	5	25,519
Beryllium (Be)	200.2	200.7	ICP-OE	TR				0.5	NA
Calcium (Ca)	200.2	200.7	ICP-OE	TR				25	NA
Chromium (Cr)	200.2	200.7	ICP-OE	TR				0.5	43
Copper (Cu)	200.2	200.7	ICP-OE	TR				1	32
Iron (Fe)	200.2	200.7	ICP-OE	TR				25	188,400
Magnesium (Mg)	200.2	200.7	ICP-OE	TR				25	NA
Manganese (Mn)	200.2	200.7	ICP-OE	TR				0.5	631
Zinc (Zn)	200.2	200.7	ICP-OE	TR				2	121
Antimony (Sb)	200.2	200.8	ICP-MS	TR				0.1	2
Arsenic (As)	200.2	200.8	ICP-MS	TR				0.2	9.8
Cadmium (Cd)	200.2	200.8	ICP-MS	TR				0.02	1
Lead (Pb)	200.2	200.8	ICP-MS	TR				0.02	36
Nickel (Ni)	200.2	200.8	ICP-MS	TR				0.1	23
Selenium (Se)	200.2	200.8	ICP-MS	TR				0.1	NA
Silver (Ag)	200.2	200.8	ICP-MS	TR				0.05	1
Thallium (Tl)	200.2	200.8	ICP-MS	TR				0.1	NA
Mercury (Hg)	7473	7473	CVAA	Total			28 days	0.02	0.18

Notes:

TR - Total recoverable metals from bulk sediment

PQL - Practical Quantitation Limit

mg/kg - milligrams per kilogram

Sample containers should be plastic and capable of holding the required sample volume.

<sup>1</sup>EPA's *Methods for the Determination of Metals in Environmental Samples*, Supplement I, May 1994 (Series 200 Methods)

<sup>2</sup>*Development and Evaluation of consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*. Environ. Contam. Toxicol. Vol. 39, pp. 20-31. 2000.

<sup>3</sup>Not applicable - no established criteria for aluminum

<sup>4</sup>*Consensus-based sediment guidelines: Recommendations for use & application*. Wisconsin Dept. of Natural Resources, Madison, WI. Report No. WT-732-2003. December, 2003.



**Table 10.0-1**  
**ESAT Region 8 - Metals QC Criteria**

QC Check / Symbol	Explanation	Run Frequency	Acceptance Criteria	Corrective Action
Initial Calibration Verification (ICV)	Certified standard or standard from a different lot/source than calibration standards	Beginning of run to verify calibration	90-110% recovery (%R) of "true value"	Terminate analysis, restandardize
Continuing Calibration Verification (CCV)	Approximate mid-range standard made from working standards stock	Every 10 unknowns and at end of run	90-110%R "True" value	Re-analyze immediately (once). Then: Restandardize and rerun all samples following last "acceptable" CCV. If recovery >110% and <120% and all associated samples (same analyte) show non-detected, no action required.
Spectral/Mass Interference Check for ICP-OE & ICP-MS (ICSA / ICSAB)	Analyze spectral interferents at high concentrations alone (ICSA) and with other target analytes (ICSAB) to evaluate the effect on analyte recovery	Once per analytical run, prior to sample analyses	ICSAB: $\pm 20\%$ R 'true value' ICSA: $\pm 20\%$ R 'true value' or $< \pm$ PQL whichever is greater	Evaluate the sample analyte levels. Rerun ICSA/AB or use an alternate wavelength. If interferent levels in the samples don't approach ICSA interferent levels, no action is required. If necessary, recalculate IECs & rerun associated samples
Calibration Blanks, Initial & Continuing (ICB & CCB)	Blank with same reagents as working standards; i.e. zero point on curve	Beginning, end, and after each ICV/CCV during analytical run	$\leq \pm$ PQL	Re-analyze immediately once. If still unacceptable, terminate analysis & restandardize. Rerun all samples analyzed after last "acceptable" blank. Evaluate interferent level(s) vs samples, use prof judgement for add'l required sample reruns.
Preparation Blank (PB)	Digested or prepared blank processed identical to samples. Aliquot of clean water prepared using same reagents/volumes as unknown samples.	Once per preparation batch/per matrix, or at 5% frequency, whichever is greatest	$\leq \pm$ PQL	PB > PQL: Redigest all samples >MDL and <10x PB value PB < -PQL: Re-calibrate and re-analyze all associated samples
Matrix Spike & Matrix Spike Duplicate (MS & MSD)	Unknown sample (NOT a field blank) fortified at approximately 10-100x MDL for each target analyte. High concentration samples (spike <25% sample target analyte concentration), no calculation is required	1 per 20 unknowns per matrix, whichever is greatest (One PB Spike per PB)	Spike recovered at: 80-120% (ICP& MS) - waters 65-135% (all) - solids	Compose 1 post-digest spike (PS) and retest, note in the narrative. (Analyze original sample with PS) Evaluate duplicate reproducibility. Compare results to LFB/PBS for similar trends. If no similar trends observed, assume a matrix effect. Qualify corresponding analyte data as estimated 'J' for similar matrix samples in set.
Lab Fortified Blank (LFB or PBS)	Spike of reagent blank at same level as MS (analyze/prep identical to samples)	Recommend: once/run	85-115%R of expected (for target analytes)	Used for comparison to Matrix Spike. If MS/MSD in-control no corrective action necessary.
Lab Control Sample (LCS)	For solid & liquid digested samples. A known of similar matrix prepared the same as unknown samples.	1 per prep batch or one per matrix, whichever is greater.	Aq: 80-120%R of "true" Solids: 70-130%R of "true" or published limits	Recalibrate & reanalyze. If still unacceptable, check for corresponding high or low results in pre-digest spikes, if similar, redigest all associated samples
Serial Dilution (L)	Sample analyzed at 5x the reported analysis. (for matrix effect evaluation) Applies to analytes >50x MDL (in the original analyzed solution)	1 per 20 unknown	Diluted value 90-110% of original analysis.	Concentrations compared/reported from the analyzed solution only. Check IECs and re-analyze. May re-analyze both sample and 'L' at a higher dilution. Use professional judgement, and discuss outliers in the narrative.
Detection Limit Standard (CRI/CRA)	Low level standard $\approx 3$ -5x MDL concentration. Applies to all target analytes except Al, Ca, Fe, Mg, Na, & K	Once per analytical batch prior to unknowns	50-150%R for Sb, Pb, and Tl. 70-130%R for other target analytes*.	1. Rerun 2. If all associated samples $\geq$ CCV for outlier analyte, no action required 3. Correct instrument's sens. problem or else need to redetermine and raise reporting limits *[Al, Ca, Fe, Mg, Na, & K are monitored without corrective actions]
ICP-MS Internal Standard (IS)	IS standard solution added to all samples, blanks, and standards.	All samples and standards corrected for IS response.	60% - 125%R of IS associated with target analyte(s)	[IS recovery determined versus calibration blank response.] Dilute sample by 2, re-analyze. Continue to dilute until IS %R acceptable.

**Table 10.0-2**  
**QA/QC Calculation Algorithms**

Statistical QC Parameter Evaluated	Acronym	Analyses Applied to	Calculation Algorithm
Percent Recovery	%R	Spike recovery determinations	$\%R = ((C_s - S_a) \div (S_a)) \times 100$
Percent Recovery	%R	ICV/CCV, ICSAB, LCS	$\%R = (A_T \div T) \times 100$
Relative Percent Difference	RPD	Variance between duplicates	$RPD = ((C - C_D) \div ((C + C_D) \div 2)) \times 100$
Percent Difference	%D	Serial dilution variance	$\%D = ((C - C_L) \div C) \times 100$

Notes:

C = Sample extract concentration

C<sub>s</sub> = Sample extract, spiked concentration

S<sub>a</sub> = Spike amount added

T = True (possibly certified) amount in standard solution

Hardness = (Ca, mg/L)\*2.497 + (Mg, mg/L)\*4.118

C<sub>D</sub> = Duplicate sample concentration

C<sub>L</sub> = Sample extract concentration, dilution factor corrected.

AT = Analyzed concentration for the known standard.

## **Figures**



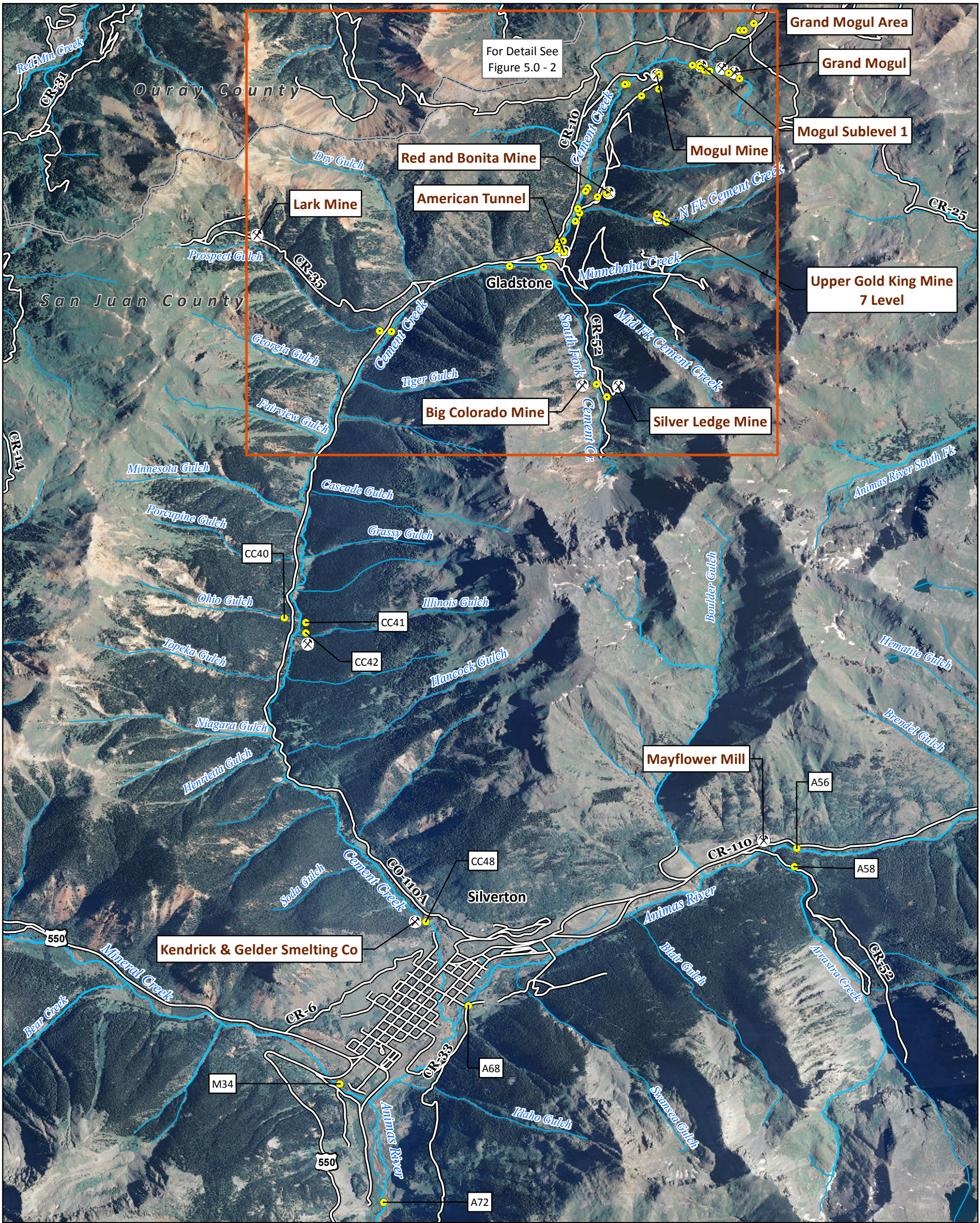


Figure 5.0-1

Upper Animas Mining District Area Overview  
Upper Animas River and Cement Creek, Silverton, CO

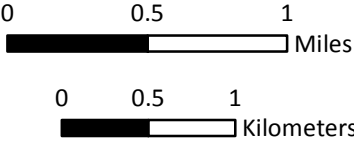
- Sample Locations
- Mine Locations
- Rivers and Streams
- Roads
- County Boundaries

Date: September 20, 2012

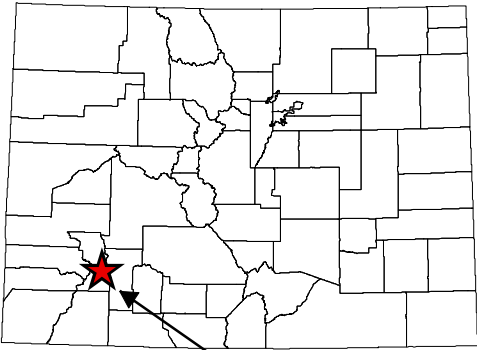
Data Sources:  
Sample Locations: U.S. EPA Region 8 (2012)  
Mine Locations: U.S. EPA and ESAT (2012)  
Roads: Navteq (2009)  
Rivers and Streams: CDOW 1:24k (2004)  
County Boundaries: U.S. Census Bureau (2009)  
Image: USDA NAIP (2009)

Coordinate System/Projection:  
UTM Zone 13 North, NAD 83, Meters

TechLaw

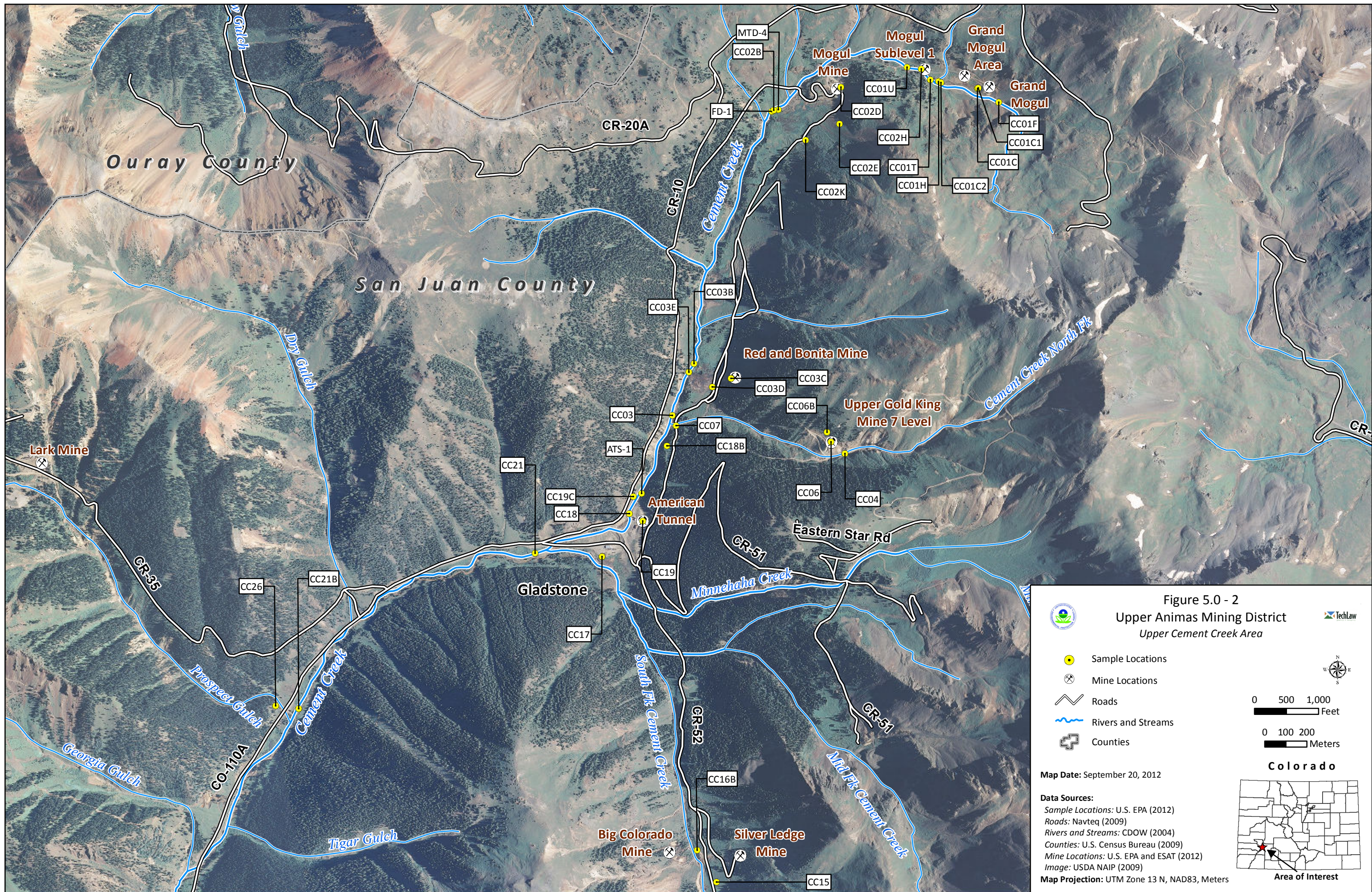


Colorado










Area of Interest





**Figure 5.0 - 2**  
**Upper Animas Mining District**  
**Upper Cement Creek Area**

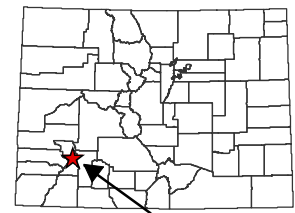
 Sample Locations  
 Mine Locations  
 Roads  
 Rivers and Streams  
 Counties

0 500 1,000 Feet  
0 100 200 Meters

**Colorado**

**Map Date:** September 20, 2012

**Data Sources:**  
Sample Locations: U.S. EPA (2012)  
Roads: Navteq (2009)  
Rivers and Streams: CDOW (2004)  
Counties: U.S. Census Bureau (2009)  
Mine Locations: U.S. EPA and ESAT (2012)  
Image: USDA NAIP (2009)  
**Map Projection:** UTM Zone 13 N, NAD83, Meters

  
**Area of Interest**



## **Standard Operating Procedures**

Effective Date: 03/30/2012

Replaces SOP: N/A

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## Surface Water Sampling

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### APPROVED:

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DCN: EP8-6-6513

This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

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Effective Date: 03/30/2012

Replaces SOP: N/A

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## **1.0 PURPOSE**

The purpose of this Standard Operating Procedure (SOP) is to guide field personnel on general surface water sampling procedures. Not all situations are accounted for; therefore site reconnaissance is a key factor in determining sampling techniques that may be utilized. Always consult the site-specific Sampling and Analysis Plan and Quality Assurance Project Plan (SAP/QAPP) before deployment to a surface water sampling event.

## **2.0 SCOPE AND APPLICABILITY**

This SOP is applicable to the collection of representative liquid samples from streams, rivers, lakes, ponds, lagoons, and surface impoundments utilizing direct method sampling procedures. This method may be varied or changed as required, dependent upon site conditions, equipment limitations or other procedural limitations. These are the preferred methodologies and should be implemented as closely as possible. Any deviations from these procedures should be discussed with site managers in order to confirm that data objectives are being met. All procedures employed should be documented and associated with the final report. Mention of trade names or commercial products does not constitute TechLaw, Inc. endorsement or recommendation for use.

This SOP is to be used in conjunction with other relevant and applicable documents which may include:

- Water Quality Measurement Procedures
- Sample Preservation Procedures
- Sediment Sampling Procedures
- Pore Water Sampling Procedures
- Field Sampling Procedures

The following documentation should be included to assist in preparing for and conducting surface water sampling activities:

- Health and Safety Plan (HASP)
- Sampling and Analysis Plan (SAP)
- Quality Assurance Project Plan (QAPP)
- Any other site-specific planning documents

## **3.0 SUMMARY OF METHOD**

This SOP is intended to provide guidance on collection of surface water. Sampling situations vary widely, therefore, no universal sampling procedure can be recommended. However, sampling of aqueous liquids from the above mentioned sources is generally accomplished through use of the direct method technique (filling sample containers directly from the source) and transfer devices (collecting the sample with a container and then transferring to another container). This allows for the collection of representative samples of surface water from streams, creeks, rivers, lakes, ponds, and other impoundments. Note that for certain types of sampling, transfer devices are not appropriate. Volatile Organic Analysis and Semi-Volatile Organic Analysis samples should always be sampled directly if possible. Also, proper decontamination or conditioning of transfer devices must occur in order to avoid cross-contamination.

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## 4.0 ACRONYMS AND DEFINITIONS

°C	Degrees Celsius
COC	Chain of Custody
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
EDI	Equal Discharge Increment
EWI	Equal Width Increment
GPS	Global Positioning System
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	High Density Polyethylene
LDPE	Low Density Polyethylene
mL	Milliliter
OSHA	Occupational Health and Safety Administration
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
VCF	Ventrical at Centroid of Flow

Equal Discharge Increment (EDI): A surface water sampling strategy that requires isokintetic water sampling from locations in a moving body of water that have the same discharge rate.

Equal Width Increment (EWI): A surface water sampling strategy that requires isokinetic water sampling from established equidistant intervals in a moving body of water.

Global Positioning System (GPS): A geospatial referencing tool that is used for mapping and identification.

Sampling and Analysis Plan (SAP): A site-specific document that details events to take place in the field.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

Quality Assurance Project Plan (QAPP): A site-specific document that specifies quality assurance activities and data quality objectives.

Ventrical at Centroid of Flow (VCF): A sampling strategy similar to EDI sampling where only one location along a transect is used to collected the isokinetic water sample.

## 5.0 HEALTH AND SAFETY

When working with potentially hazardous materials or in hazardous situations, personnel must understand and comply with the site-specific SAP/QAPP and HASP before the sampling event begins. More specifically, when sampling streams or surface impoundments containing known or suspected hazardous substances, adequate personal protective equipment such as nitrile gloves, safety glasses,

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and waders are necessary to prevent contact with contaminants during sampling. When entering a stream, hazardous situations may exist requiring the use of adequate personal safety equipment including personal floatation devices and non-slip footwear. When conducting sampling from a boat in an impoundment or flowing waters, appropriate boating safety procedures should be followed.

## **6.0 CAUTIONS**

Only collect surface water samples if it can be done so safely. Many unsafe conditions exist on streams, rivers, ponds, and other surface water impoundments. Consult the site HASP before performing any sample collection.

## **7.0 INTERFERENCES**

There are three primary interferences or potential problems with surface water sampling. These include cross-contamination of samples, improper sample collection, and improper sample preservation.

1. Cross-contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the Sampling Equipment Decontamination SOP #FLD-02.00.
2. Improper sample collection can involve disturbance of the stream substrate and/or sampling in an obviously disturbed area. To minimize potential for unrepresentative samples, consider sampling from downstream to upstream to avoid sampling where the substrate has been disturbed. Site sampling often involves multiple sampling procedures being deployed simultaneously. Therefore, well-organized team member coordination is essential to prevent improper sample collection.
3. Sample preservation is a critical component of sample collection. If the wrong preservative is used, the sample must be re-collected if possible. Improperly preserved samples cannot be analyzed. Refer to the Sample Preservation SOP #FLD-03.00 for proper field sample preservation guidelines.

## **8.0 PERSONNEL QUALIFICATIONS**

Any personnel who are involved with field sampling activities must be cleared for health and safety. Clearance includes medical monitoring, respirator fit testing, and Occupational Health and Safety Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training. Personnel who will be collecting surface water samples should familiarize themselves with this and other pertinent SOPs including: Sample Equipment Decontamination SOP #FLD-02.00; Sample Preservation SOP #FLD-03.00; Water Quality Measurements with the In-Situ<sup>®</sup> Multi-Parameter Meter SOP #FLD-09.00; Sample Custody and Labeling SOP #FLD-11.00; and General Field Sampling Protocols SOP #FLD-12.00.

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## 9.0 EQUIPMENT AND SUPPLIES

Equipment needed for collection of surface water samples may include:

HASP Required Gear - personal floatation device, waders/gloves, proper footwear, safety glasses, insulating clothing for cold water, etc.

Mapping & Location Tools - GPS units, site/local area maps, compass, tape measure, survey stakes, pin flags, camera, 2-way radios

Documentation Supplies - field log book, field data sheet, Chains of Custody (COCs), labels, clear tape, pens, permanent marker, waterproof paper

Sampling Tools - plastic or other appropriate composition transfer device, bucket, rinse bottles, purified water, paper towels, filtering equipment, vacuum pump tool, vacuum pump stand, preservative, Ziploc™ plastic bags, cooler(s), ice, thermometer, preservative waste containment

Sample Containers - High-density polyethylene/Low Density Polyethylene (HDPE/LDPE) or other appropriate composition containers (250 milliliter [mL] and 500 mL are frequently used).

See Table 9.0-1 for a detailed list of surface water sampling equipment.

## 10.0 STANDARDS AND REAGENTS

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment (refer to SOP's #FLD-02.00 and #FLD-03.00). The preservatives required are specified by the analysis to be performed and will be specified in the SAP/QAPP but usually include nitric acid (Total Recoverable and Dissolved Metals samples) and phosphoric acid (Dissolved Organic Compound samples). Field sampling personnel should also be aware of any special sampling considerations, contamination issues, and sample compositing and mixing methods that could affect the sampling efforts. Appropriate regional guidance and procedures should be consulted for detailed sample collection, preservation, handling and storing, equipment decontamination, and Quality Assurance/Quality Control (QA/QC) procedures. Field sampling personnel should preserve and immediately cool all water samples to 4 degrees Celcius (°C) ( $\pm 2^{\circ}\text{C}$ ) upon collection and samples should remain cooled until the time of analysis (do not freeze water samples).

## 11.0 PROCEDURES

### 11.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods required, and the types and amounts of equipment and supplies needed. Use the site-specific SAP/QAPP for guidance to determine which kind of samples need to be collected.
2. Obtain the necessary sampling and monitoring equipment.
3. Decontaminate equipment according to the procedures outlined in SOP #FLD-02.00, or use triple rinsed, dedicated disposable sample containers (non-filtering and not pre-preserved).

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Replaces SOP: N/A

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4. Prepare scheduling and coordinate with staff, clients, and regulatory agencies where appropriate. It is also important to obtain site access agreements if sampling is to occur on private property.
5. Perform a general site survey prior to site entry in accordance with the site-specific HASP.
6. Use stakes, flagging, GPS markers, or photos to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

Generally, factors to consider in the selection of a device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

- a. Can the sample be collected directly from the source? (i.e. is a transfer device needed for sample collection?)
- b. What is the desired depth at which you wish to collect the sample?
- c. What is the overall depth and flow direction of river or stream?
- d. What type of analysis will be run (Total Recoverable Metals, Dissolved Metals, Alkalinity and Anions, etc.)?

## **11.2 Sample Container Composition**

A sample container should be selected based on analysis to be performed. A triple rinse should be performed on any sample container being used for direct sample collection. Filtered sample bottles or pre-preserved bottles should never be rinsed first.

## **11.3 Sample Collection**

1. Direct collection is the optimal procedure for sample collection. After rinsing, the sample should be collected in a well-mixed area, as close to the middle of the stream as possible, in-between the streambed and the surface. The sample should be capped immediately.
2. Preserve the sample if appropriate. Refer to the site-specific SAP and SOP #FLD-03.00 for correct methods. The sample should be clearly labeled (and bagged in order to keep samples from the same location together) before being placed in a cooler on ice.
3. Record all pertinent site data (usually date, time, pH, conductance, dissolved oxygen, temperature, site ID, and anomalies) in the field logbook, field data sheets and/or sample container labels.
4. Complete the COC record. Refer to SOP #FLD-11.00 for guidelines on sample custody and labeling documentation.

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Replaces SOP: N/A

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5. Attach custody seals to cooler prior to shipment where applicable. Refer to SOP #FLD-11.00 for guidelines on sample custody and labeling.
6. If a non-direct method was used for sampling (i.e. a bucket from a bridge or a dip sampler), decontaminate or condition all sampling equipment prior to the collection of additional samples with that sampling device as required by SOP #FLD 02.00. Sections 11.3.4 and 11.3.5 describe a few of the non-direct sampling methods that may be useful in Region 8.

### **11.3.1 Direct Method**

For streams, rivers, and lakes, the direct method may be utilized to collect water samples from the surface directly into the sample container. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Samples should be collected prior to all other activities as specified in the SAP/QAPP to avoid disturbing the substrate. Rinse the sample container three times (unless it's filtered or pre-preserved) with site water before procuring a sample.

### **11.3.2 Dip Sampling**

Dip sampling is useful in situations where a sample is to be recovered from an outfall pipe or from a bridge where direct access is limited. The long handle or rope on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.
2. Extend the device to the sample location and collect the sample by dipping the sampler into the water at the sampling location.
3. Triple rinse the sampler with the site water
4. Retrieve the sampler and transfer the sample to the appropriate (triple rinsed) sample container

### **11.3.3 Synoptic Sampling**

Synoptic sampling is a strategy used for evaluating a surge of water as it moves downstream. In general, the flow rate should be determined before executing a synoptic sampling event. Flow measurements are used to calculate when a surge of water will pass by a certain point or sample location. Floating visual objects may also be used to accurately determine when a surge of water passes by a sampling location. The synoptic sampling strategy is useful in determining where contaminants may be entering a watershed through seeps, fens, or other inflows that may not be visible. Below is a general guideline on synoptic sampling:

- Identify sample locations
- Conduct flow measurements; or test a floating object (ping pong ball,

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Replaces SOP: N/A

- tangerine, etc.) to see if it will float through to the last sampling location (some objects may get caught in eddies or shallow areas)
- Calculate when the surge of water will pass through each sampling location
- Position sampling personnel or equipment where a sample can be captured at the required time
- Process samples

#### **11.3.4 Large Stream or River Sampling**

There are several techniques for sampling large rivers or streams. The most commonly used are Equal-Width Increment (EWI) sampling, Equal Discharge Increment (EDI) sampling, Single Vertical at Centroid of Flow sampling (VCF), dip sampling (section 11.3.2), direct method sampling (section 11.3.1), discrete sampling, and pump sampling (USGS, 2006). Below is a brief description of the sampling methods that have not yet been mentioned in this document:

EWI Method – A stream cross-section is divided into equal width intervals, and samples are collected by lowering and raising a sampler through the water column at the center of each interval. This produces a discharge weighted sample that is proportional to stream flow. This method cannot be used if the stream flow is less than what is required to fill the sampler during the isokintetic (constant rate) motion.

EDI Method – The objective of this method is to obtain a discharge weighted sample that represents the entire flow through a cross-section by obtaining a series of samples. For this method, the flow in the cross-section must be divided into points of equal discharge. Equal volume and depth integrated samples are collected at the center of the equal discharge interval along the cross-section. Flow measurements or historical data is necessary to determine interval number (usually more than 4, but less than 20) and location. This method may also require additional personnel to sample a large cross-section. If conducted properly, both the EWI and EDI methods should produce identical results.

VCF Method – This method is a simple version of the EDI method, but only one sample is collected at flow center (usually a smaller river or stream). This is to be used if the sample location is known to be homogenous and is warranted by the sampling plan objectives. Flow data should be obtained to determine where the flow center is located.

#### **11.3.5 Shallow Stream and Still Water Sampling**

Shallow streams and still water such as a pond are common locations to sample in Region 8. Below are three methods (in addition to ones mentioned above) that may be required.

Discrete (point) Sampling – This method is achieved by lowering a sample container to a specific depth in a body of water then opening and closing the container to obtain the sample.

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Pump Sampling – This method is used to collect single point samples using a suction-lift or submersible pump. These are not used for collecting isokinetic samples (EWI, EDI, or VCF). Using the pump method is limited by electrical needs in remote areas. Always consult the SAP for sampling objective requirements.

Syringe Sampling – A 50 mL syringe can be used to collect sample from very shallow locations to avoid contact with substrate.

## 12.0 DATA RECORDS AND MANAGEMENT

Once collected, samples are preserved, labeled, and stored for transport. A COC must accompany all samples during transport and transfer between entities. Sample labels should contain the following information:

- Site Identification
- Date sampled
- Sampler initials
- Time
- Analysis to be performed

## 13.0 QUALITY CONTROL AND ASSURANCE

1. The following general QA procedures apply:
2. All data must be documented on field data sheets or within site logbooks.
3. In general, concurrent (duplicate) sample collection at a frequency of 1/20 is required for most sampling activities. Blanks at a frequency of one per day are also generally required. Consult the corresponding SAP/QAPP for specific QA/QC sampling frequency. Below is a list of typical QA/QC sample types and the inaccuracy they are intended to detect:
  - Field blank – sample contamination due to field personnel/procedures
  - Equipment blank – equipment contamination due to inadequate decontamination procedures
  - Sequential replicates – samples are pulled one after another to detect variability among field activities (collection, preservation, handling, etc.)
  - Split samples – division of one sample into two, then submitting for identical analysis in order to detect variability in the process from collection to analysis
  - Concurrent or collocated replicate samples (often referred to as “duplicate” samples) – two samples collected at the same location at the same time, intended to detect variability inherent in collection, processing, and handling procedures; Relative percent difference is usually calculated from these samples.
4. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer unless otherwise specified in the work plan or SAP/QAPP. Equipment calibration activities must be conducted and documented prior to sampling and/or operation of equipment.



5. Document any deviations from SOPs, work plan, SAP/QAPP, etc.

## **14.0 REFERENCES**

Environmental Protection Agency (EPA) Guidance for Preparing Standard Operating Procedures, EPA QA/G-6, April 2007.

U.S. Geological Survey. 1977. National Handbook of Recommended Methods for Water Data Acquisition. Office of Water Data Coordination, Reston, Virginia. (chapter updates available)

U.S. Geological Survey 2006. National Field Manual for the Collection of Water Quality Data. Chapter A4, version 2.0, Office of Water Quality.

Environmental Protection Agency (EPA), 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

Environmental Protection Agency (EPA), Environmental Response Team, Standard Operating Procedures - Surface Water Sampling: U.S. Environmental Protection Agency, 1994, SOP #2013.

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Replaces SOP: N/A

**Table 9.0-1 Surface Water Sampling Equipment**

<u>Category</u>	<u>Item</u>	<u>Use</u>	<u>Comment</u>
Health and Safety	Gloves	Protection from absorption of contaminants	Nitrile or neoprene are recommended
Health and Safety	Waders	Slip/contaminant protection, warmth	Any type are acceptable
Health and Safety	Safety Glasses	Eye protection	Sunglasses for UV protection
Health and Safety	Layered Clothing	Protection from hypothermia	Polyester base layers only
Mapping/Location	GPS unit	Sample station locating	Pre-loaded with site locations
Mapping/Location	Maps	Location identification	Most current information required
Mapping/Location	Two-way radios	Communication	Extra batteries or charger required
Documentation	Field Logbook	Site data and conditions documentation	Waterproof pages
Documentation	Field Data Sheets (waterproof)	Marsh McBirney Flows	
Documentation	Chain of Custody	Sample handling/identification	Generated using Scribe
Documentation	Labels	Sample identification	Generated using Scribe
Documentation	Clear tape & Scissors	Label protection	
Sampling Tools	Bucket/Transfer Device	Sample transfer (if required)	Decontaminated between samples
Sampling Tools	Vacuum Pump	Dissolved sample processing	
Sampling Tools	Vacuum Stand	Dissolved sample processing	
Sampling Tools	Ziploc baggies	Sample containment	
Sampling Tools	Water Chemistry meters	In-situ water quality data gathering	Temp, pH, dissolved oxygen, conductivity
Sampling Tools	Flow measurement equipment	Flow measurements	
Sampling Tools	Cooler	Sample containment	Samples to be kept at 4 °C
Sampling Containers	250 ml HDPE/LDPE	Total recoverable metals samples	
Sampling Containers	250 ml HDPE/DLPE filtered bottles	Dissolved Metals/ DOC samples	Single use only
Sampling Containers	500 ml HDPE/LDPE	Alkalinity+Anions samples	
Sampling Containers	VOA Vials	Volatile and Semi-Volatile organics analysis	
Reagents	Nitric Acid(HNO3) ampules	For preserving metals samples	
Reagents	Phosphoric Acid (H3PO4) ampules	For preserving DOC samples	
Reagents	Hydrochloric (HCl) Acid	For preserving VOA samples	
Reagents	CaCO3 Acid waste Containment	Ampule/acid waste disposal	Usually in a 1 liter cubitainer
Reagents	pH and Conductivity standards	Calibration of water quality equipment	Quantity for each day of sampling

Effective Date: 3/30/2012

Replaces SOP: N/A

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## Sample Preservation

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### APPROVED:

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ESAT Region 8 Task Lead

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Date

DCN: EP8-6-6513

This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

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Replaces SOP: N/A

## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standard approach for Environmental Protection Agency (EPA) and Environmental Services Assistance Team (ESAT) Region 8 personnel to preserve samples during field activities.

## 2.0 SCOPE AND APPLICATION

This SOP is specifically intended for application by EPA and ESAT personnel who conduct sample preservation in field work activities.

## 3.0 SUMMARY OF METHOD

For purposes of this SOP, proper sample preservation techniques and methods are reviewed. This SOP is based on industry standard instructions.

## 4.0 ACRONYMS AND DEFINITIONS

ESAT	Environmental Services Assistance Team
DOC	Dissolved Organic Carbon
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
MSDS	Material Safety Data Sheet
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling Analysis Plan
SOP	Standard Operating Procedure
EPA	United States Environmental Protection Agency
VOA	Volatile Organic Analytes

Ampoule: A small sealed vial which is used to preserve a sample usually nitric, phosphoric, or sulfuric acid.

Health and Safety Plan (HASP): A site-specific document that outlines potential site hazards and hazard mitigation practices.

Material Safety Data Sheets (MSDS): A form with data regarding the properties of a particular substance.

Personal Protective Equipment (PPE): Refers to protective clothing, helmets, goggles, or other garment designed to protect the wearer's body from injury by blunt impacts, electrical hazards, heat, chemicals, and infection, for job-related occupational safety and health purposes.

Quality Assurance Project Plan (QAPP): A site-specific document that specifies quality assurance activities and data quality objectives.

Sampling and Analysis Plan (SAP): A site-specific document that specifies events to take place in the field.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

## **5.0 HEALTH AND SAFETY**

The procedures outlined in this SOP have general health and safety issues associated with it. This includes the use of proper PPE when conducting sample preservation. The most important health and safety items while preserving samples are latex gloves to prevent skin contact and safety eyewear to protect from splash hazards. Always refer to the applicable HASP and MSDS any time field work or preservation activities are conducted.

## **6.0 EQUIPMENT**

- Ampules
- PPE (gloves, eye protection, cover-alls)
- First-Aid kit
- Disposal equipment (ampoule waste container, garbage bags)
- Sample Filter equipment

## **7.0 SAMPLE PRESERVATION**

Complete and unequivocal preservation of samples with total stability of every constituent maintained, regardless of the nature of the sample, can never be achieved. At best, preservation techniques can only minimize the chemical and biological changes that inevitably continue after the sample is removed from the parent source. Proper preservation methods, such as pH control, chemical addition, filtration, and refrigeration are intended to retard biological and chemical effects, reduce volatility of constituents, and limit absorption effects.

Because of the potential vulnerability samples may have to a number of influences, it is best that sample analyses occur as soon as possible after collection. However, since the majority of sampling events do not have on-site mobile laboratories, and travel time from the field to the laboratory may be multiple days, it is critical that effective sample preservation techniques are employed to ensure sample integrity.

### **7.1 Chemical Influences on Samples**

Chemical changes to samples may result when physical conditions alter the chemical structure of the constituents. Many of the chemical processes that occur once a sample is taken will ultimately depend on the type and amount of sample taken, the medium to which the sample is housed, and the storage and transportation environment for that particular sample. Examples of chemical effects to samples might include metal cations precipitating as hydroxides or forming complexes with other constituents; cations or anions changing valence states under certain reducing or oxidizing conditions; or other constituents dissolving or volatilizing with the passage of time. Metal cations may also adsorb onto surfaces (glass, plastic, quartz, etc.), such as, iron and lead.

## **7.2 Biological Influences on Samples**

Biological changes may occur when a sample changes the valence of an element or a radical to a different valence. Soluble constituents may be converted to organically bound materials in cell structures, or cell lysis may result in release of cellular material into solution. Nitrogen and phosphorus cycles are examples of biological influence on sample composition.

## **7.3 Sample Types to Preserve**

Sample preservation mainly pertains to water samples (surface water, groundwater, pore water), but other sample types that might require preservation include sediment, macroinvertebrates, or waste rock. For all non-water based samples, the basic practice of storing and transporting in coolers with ice will suffice for a preservation method. However, be sure to consult with the analyzing laboratory with regard to any specific preservation requirements (for both water and non-water samples) before going into the field.

# **8.0 PRESERVATION PROCEDURES AND TECHNIQUES**

Samples collected in the field are generally preserved by chilling or chemical treatment. It is important that the sample crew be knowledgeable of the following before and during the field event:

1. The required sample-designation code for each sample.
2. The sample requirements for filtration, chilling and chemical treatment.
3. The holding time restrictions required by the analyzing laboratory.

## **8.1 Water Sample Preservation**

There are a number of things to consider when preparing for a water sampling event. Before field deployment, be sure to have all the equipment and supplies necessary to collect, preserve, store, and transport your samples in the proper way.

## **8.2 Meet Sample Volume Requirements**

Collecting sufficient sample volume is critical. There must be sufficient physical sample volume for the analysis of all required parameters and completion of all QC determinations. The type of analytical procedure(s) to be performed will often dictate the sample volume to collect. It is extremely important that samplers refer to their specific SAP and QAPP to identify and collect the correct sample volume during each sampling event. Once the sample volume requirement is understood, the appropriate container size can be chosen to accommodate the sample.

## **8.3 Proper Preservation for Water Sample**

Whether the preservation method is chilling or chemical treatment, the preservation specifics will vary based on the analysis. The variability involved in sample preservation can best be understood in the Preservation Requirement Tables (section 8.5.1 – 8.5.4). In these tables, you

will see how different analyses (physical, metals, organics, inorganics or non-metals), dictate a different set of preservation requirements.

## 8.4 Preservation Methods

Each preservation method has specific standard procedures that need to be followed when preserving a sample.

### 8.4.1 Chemical Treatment

Chemicals used for sample preservation will depend on the target analyte (see section 8.5.1 – 8.5.4). For purposes of EPA Region 8 sampling, nitric acid ( $\text{HNO}_3$ ), sulfuric acid ( $\text{H}_2\text{SO}_4$ ) hydrochloric acid ( $\text{HCl}$ ), and phosphoric acid ( $\text{H}_3\text{PO}_4$ ) are most commonly used. It is important to wear appropriate PPE when involved in any part of the sample preservation process, especially in the chemical treatment process. An MSDS should be available for all preservatives to be used on site.

Preservation chemicals for may be in the form of bulk liquid or ampoules.

Common chemical preservation in EPA Region 8 water sampling:

Measurement	Chemical Treatment
Total and Dissolved Metals	Nitric Acid ( $\text{HNO}_3$ )
Semi-Volatile Organics	Hydrochloric Acid ( $\text{HCl}$ )
Dissolved Organic Carbon (DOC)	Phosphoric Acid ( $\text{H}_3\text{PO}_4$ )
Nutrients	Sulfuric Acid ( $\text{H}_2\text{SO}_4$ )

### 8.4.2 Using Preservation Ampoules

Preservation chemicals, such as nitric acid ( $\text{HNO}_3$ ), hydrochloric acid ( $\text{HCl}$ ), and phosphoric acid ( $\text{H}_3\text{PO}_4$ ), can also come in the form of ampoules. Ampoules are small plastic or glass containers that hold an exact amount of a chemical in a liquid form. They are designed to be used once per sample.

When preparing to treat a sample with a chemical from an ampoule, first break the tip of the ampoule with two hands (while wearing proper PPE), and pour the liquid into the sample bottle. When all liquid has been removed from the ampoule, place the broken components of the glass ampoule into a specifically designated and labeled acid neutralization container that has a secure screw top. It is acceptable for one acid waste container to be used to neutralize all acids.



### 8.4.3 Using Bulk Concentrated Acid

Preservation acid can also come in the form of bulk concentrated acid, typically at a concentration level of 70%. When using bulk concentrated acid, a disposable pipet may be used to extract the necessary quantity from the parent vessel to then be released in the water sample. The pipet may be used multiple times if the same chemical is being transferred. Never cross-contaminate pipets with different chemicals or different samples.

### 8.4.4 Chilling

Chilling samples is almost always a part of the sample preservation process. Once a sample is collected (and potentially treated with chemicals) it is to be immediately packed in ice or placed in a refrigerator and maintained at a temperature of 4 degrees Celsius or less, without freezing, until analyzed. To avoid problems that can result from sample expansion, allow sufficient headspace in the sample bottle before chilling it (An exception to this method includes Volatile Organic Analytes (VOA). In the case of VOAs, do not leave head space in the sample bottle). If using glass bottles, use foam sleeves to protect them. Another method that can be used to avoid the potential of melting ice water seeping into sample bottles is the use of plastic bags to contain the samples. This method doubles as a way to group subsamples from the same sample location.

## 8.5 Preservation Requirement Tables

Preservation requirements for physical, metals, organics, and inorganic sample types can be understood in the following tables.

### 8.5.1 Physical Preservation Requirements

Measurement	Volume (ml)	Container	Preservative	Holding Time
Color	50	Plastic or Glass	Cool, 4 Degrees Celsius	48 Hours
Conductance	100	Plastic or Glass	Cool, 4 Degrees Celsius	28 Days
Hardness	100	Plastic or Glass	HNO <sub>3</sub> – pH below 2	6 Months
Odor	200	Glass	Cool, 4 Degrees Celsius	24 Hours
pH	25	Plastic or Glass	None required	Analyze Immediately
Temperature	1000	Plastic or Glass	None required	Analyze Immediately
Turbidity	100	Plastic or Glass	Cool, 4 Degrees Celsius	48 Hours

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### 8.5.2 Metals Preservation Requirements

Measurement	Volume (ml)	Container	Preservative	Holding Time
Dissolved	200	Plastic* or Glass	Filter on site first. HNO <sub>3</sub> – pH below 2	6 Months
Suspended	200	Plastic* or Glass	Filter on site. HNO <sub>3</sub> – pH below 2	6 Months
Total	100	Plastic* or Glass	HNO <sub>3</sub> – pH below 2	6 months
Dissolved (Mercury)	100	Plastic* or Glass	Filter on site first. HNO <sub>3</sub> – pH below 2	28 Days
Total (Mercury)	100	Plastic* or Glass	HNO <sub>3</sub> – pH below 2	28 Days

\*Polyethylene with a polypropylene cap (no liner) is preferred.

### 8.5.3 Organics Preservation Requirements

Measurement	Volume (ml)	Container	Preservative	Holding Time
BOD	1000	Plastic or Glass	Cool, 4 Degrees Celsius	48 Hours
COD	50	Plastic or Glass	Cool, 4 Degrees Celsius. H <sub>2</sub> SO <sub>4</sub> – pH below 2	28 Days
DOC	250	Plastic or Glass	Cool, 4 Degrees Celsius. Add H <sub>3</sub> PO <sub>4</sub> .	28 Days
Oil & Grease	1000	Glass only	Cool, 4 Degrees Celsius. H <sub>2</sub> SO <sub>4</sub> – pH below 2.	28 Days
Organic Carbon	25	Plastic or Glass	Cool, 4 Degrees Celsius. H <sub>2</sub> SO <sub>4</sub> – pH below 2.	28 Days
Phenolics	500	Glass only	Cool, 4 Degrees Celsius. HNO <sub>3</sub> – pH below 2.	28 Days
Semi-volatiles	1000	Glass only	Cool, 4 Degrees Celsius	7-14 Days

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### 8.5.4 Inorganics & Non-Metallics Preservation Requirements

Measurement	Volume (ml)	Container	Preservative	Holding Time
Acidity	100	Plastic or Glass	Cool, 4 Degrees Celsius	14 Days
Alkalinity	100	Plastic or Glass	Cool, 4 Degrees Celsius	14 Days
Bromide	100	Plastic or Glass	None required	28 Days
Chloride	50	Plastic or Glass	None required	28 Days
Cyanides	500	Plastic or Glass	Cool, 4 Degrees Celsius. NaOH – pH over 12. 0.6g ascorbic acid (only in presence of residual chlorine)	14 Days (24 Hours when sulfide is present)
Fluoride	300	Plastic or Glass	None required	28 Days
Iodide	100	Plastic or Glass	Cool, 4 Degrees Celsius	24 Hours
Nitrogen (Ammonia)	400	Plastic or Glass	Cool, 4 Degrees Celsius. H <sub>2</sub> SO <sub>4</sub> – pH below 2	28 Days
Nitrate & Nitrite	100	Plastic or Glass	Cool, 4 Degrees Celsius. H <sub>2</sub> SO <sub>4</sub> – pH below 2	28 Days
Nitrate	100	Plastic or Glass	Cool, 4 Degrees Celsius	48 Hours
Nitrite	500	Plastic or Glass	Cool, 4 Degrees Celsius	48 Hours
Dissolved Oxygen (Winkler)	300	Glass Bottle with Top	Fix on site and store	8 Hours
Phosphorus (Ortho-P, dissolved)	50	Plastic or Glass	Filter on site. Cool, 4 Degrees Celsius.	48 Hours
Phosphorus (Hydrolyzable)	50	Plastic or Glass	Cool, 4 Degrees Celsius. H <sub>2</sub> SO <sub>4</sub> – pH below 2.	28 Days
Phosphorus (Total)	50	Plastic or Glass	Cool, 4 Degrees Celsius. H <sub>2</sub> SO <sub>4</sub> – pH below 2.	28 Days
Phosphorus (Total, Dissolved)	50	Plastic or Glass	Filter on site. Cool, 4 Degrees Celsius.	24 Hours
Silica	50	Plastic only	Cool, 4 Degrees Celsius	28 Days
Sulfate	50	Plastic or Glass	Cool, 4 Degrees Celsius	28 Days
Sulfide	500	Plastic or Glass	Cool, 4 Degrees Celsius. Add 2 ml Zinc Acetate plus NaOH – pH over 9.	7 Days

## **9.0 PERSONNEL QUALIFICATIONS**

All personnel who participate in field activities are required to obtain clearance in three mandatory health and safety programs: medical monitoring, respirator fit testing, and OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training. It is important for field personnel to familiarize themselves with other applicable SOP's such as Sampling Equipment Decontamination SOP FLD 02.00, Surface Water Sampling SOP FLD 01.00, Sample Custody and Labeling SOP FLD 11.00, and General Field Sampling Protocols SOP FLD 12.00. In addition, any personnel who will participate in sample preservation activities must read, understand, and sign the site-specific HASP and SAP/QAPP.

## **10.0 REFERENCES**

Environmental Protection Agency. 1983. Sample Preservation. pp.xv-xx. In Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020. EPA Cincinnati, Ohio, USA.

United States Geological Survey. 2002. Processing of Water Samples (Version 2, 4/02). P. 89-94. In National Field Manual for the Collection of Water-quality data. USGS, Washington DC, USA.

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## Shallow Stream Sediment Sampling

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This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

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## **1.0 PURPOSE**

The purpose of this Standard Operating Procedure (SOP) is to provide field personnel a set of guidelines for the proper collection of stream sediment samples.

## **2.0 SCOPE AND APPLICABILITY**

This SOP is applicable to the collection of shallow stream sediment samples. Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:

- Toxicity
- Biological availability and effects of contaminants
- Benthic biota
- Extent and magnitude of contamination
- Contaminant migration pathways and source
- Fate of contaminants
- Grain size distribution

The methodologies discussed in this SOP are applicable to the sampling of sediment in lotic environments. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions, equipment limitations and requirements of the site-specific Sampling and Analysis Plan (SAP). However, if modifications occur, they should be documented in field data sheet/field notebook and discussed in reports summarizing field activities and analytical results. For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer in rivers and streams. Mention of trade names or commercial products for use in sediment sample collection does not constitute endorsement or recommendation for use.

## **3.0 SUMMARY OF METHOD**

Sediment samples may be collected using a variety of methods and equipment, depending on the depth of the aqueous layer, the portion of the sediment profile required (surface vs. subsurface), the type of sample required (disturbed vs. undisturbed), contaminants present, and sediment type. Sediment is collected from beneath an aqueous layer directly, using a hand held device such as a shovel, trowel, or plastic scoop. Following collection, sediment is transferred from the sampling device to an appropriate sample container. If composite sampling techniques are employed, multiple grabs are placed into a container constructed of inert material, homogenized, and transferred to sample containers appropriate for the analyses requested.

*The homogenization procedure should not be used if sample analysis includes volatile organics.* In this case, if sediment is to be analyzed for volatile organics then the sample must be transferred to the appropriate sample container directly after collection. The sample bottle is filled completely and tapped lightly to get the trapped air out of the bottle. If the sediment settles in the bottle creating airspace then additional sediment should be collected. Repeat this step as many times necessary in order to have the sample bottle completely filled without having any air gaps.

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#### 4.0 ACRONYMS AND DEFINITIONS

COC	Chain of Custody
GPS	Global Positioning Systems
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	High-Density Polyethylene
OSHA	Occupational Health and Safety
QA	Quality Assurance
SAP/QAPP	Sampling and Analysis Plan/Quality Assurance Project Plan
SOP	Standard Operating Procedure

Chain of Custody (COC): A chronological document that tracks movement of samples between entities from collection to disposal.

Composite Sampling: Sampling from several points or intervals and consolidating them into a larger sample.

Discrete Sampling: Sampling from a single location.

Global Positioning System (GPS): A geospatial referencing tool that is used for mapping and identification

Health and Safety Plan (HASP): A site specific document that identifies safety hazards and proper safety procedures. This normally includes hospital route maps and material safety data sheets.

Sampling and Analysis Plan (SAP): A site specific document that specifies events to take place in the field.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

Quality Assurance Project Plan (QAPP): A site specific document that specifies quality assurance activities and data quality objectives.

#### 5.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow United States Environmental Protection Agency (EPA), Occupational Safety and Health Agency (OSHA), and corporate health and safety procedures. More specifically, when sampling sediment from water bodies, physical hazards must be identified and adequate precautions must be taken to ensure the safety of the sampling team. The team member collecting the sample should not get too close to the edge of the water body, where bank failure may cause loss of balance. To prevent this, the person performing the sampling should be on a lifeline, and be wearing adequate protective equipment. If sampling from a vessel, appropriate protective measures and procedures must be implemented.



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## **6.0 CAUTIONS**

Only collect sediment samples if it can be done so safely. Many unsafe conditions exist on streams and rivers. Also, review the SAP/QAPP or any other planning documents for analytical requirements and equipment selection. Consult the site HASP before performing any sample collection.

## **7.0 INTERFERENCES**

Substrate particle size and organic matter content are a direct consequence of the flow characteristics of a water body. Contaminants are more likely to be concentrated in sediments typified by fine particle size and high organic matter content. This type of sediment is most likely to be collected from depositional zones. In contrast, coarse sediments with low organic matter content do not typically concentrate pollutants and are generally found in erosion zones.

## **8.0 PERSONNEL QUALIFICATIONS**

All personnel who participate in field activities are required to obtain clearance in three mandatory health and safety programs: medical monitoring, respirator fit testing, and Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training. In addition to this, any personnel who will participate in sediment sampling activities must read, understand, and sign the site specific HASP and the associated SAP/QAPP. Additionally, field personnel would benefit from understanding relevant SOPs including Sampling Equipment Decontamination SOP FLD 02.00, Sample and Labeling SOP FLD 11.00, and the General Field Sampling Protocols SOP FLD 12.00.

## **9.0 EQUIPMENT AND SUPPLIES**

Equipment needed for collection of sediment samples may include:

Health and Safety Plan (HASP) - Personal floatation device, life line, neoprene waders/gloves, proper footwear, safety glasses, insulating clothing for cold water, etc.

Mapping & Location Tools - GPS units, site/local area maps, tape measure, compass, survey stakes, pin flags, camera, and 2-way radios.

Documentation - Field log book, field data sheet, chain of custody (COC), labels & clear tape, pens/sharpie, waterproof paper.

Sampling Tools - Plastic or other appropriate composition scoop, shovel, spade, trowel, homogenization container with mixing tool, rinse bottle, purified water, and paper towels.

Sample Containers -High-density polyethylene (HDPE) or other appropriate composition containers (50 mL and 1 liter [bulk] are frequently used), amber glass jars (organics analysis) labels, clear tape, pens, permanent marker, sealable plastic bags, cooler(s), and ice.

See Table 9.0-1 for a detailed list of sediment sampling equipment.

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## **10.0 STANDARDS AND REAGENTS**

Reagents are not used for preservation of sediment samples.

## **11.0 PROCEDURES**

### **11.1 Sample Preservation, Containers, Handling and Storage**

Chemical preservation of solids is not recommended. Cooling to 4 degrees Celsius (°C) is recommended for sediment samples. HDPE containers with Teflon™ lined caps are typically used for sediment samples. Sample container size is typically 50 milliliter (mL) for metal analysis and 1 liter for sediment toxicity testing. However, the sample volume is a function of the analytical requirements and will be specified in the SAP/QAPP. If analysis of sediment from a discrete depth or location is desired, sediment is transferred directly from the sampling device to a labeled sample container(s) of appropriate size and construction for the analyses requested. Transfer is accomplished with a decontaminated stainless steel or plastic lab spoon or equivalent.

If composite sampling techniques or multiple grabs are employed, equal portions of sediment from each location are deposited into a stainless steel, plastic, or other appropriate composition containers. The sediment is then homogenized thoroughly, to obtain a composite sample that is representative of the area and is then transferred to a labeled container. Transfer of sediment is accomplished with a stainless steel or plastic lab scoop or equivalent. Samples for volatile organic analysis must be transferred directly from the sample collection. It is important that when collecting sediment for volatile organic compounds analysis, the sample container is filled completely full and the sample container is tapped lightly to ensure all air is purged from the sample. This is done to minimize loss of contaminant due to volatilization.

All sampling devices should be decontaminated following procedures described in the Sample Equipment Decontamination SOP FLD 02.00. The sampling device should remain in its wrapping until it is needed. Each sampling device should be used for only one sample. Although disposable sampling devices for sediment are generally impractical due to cost and the large number of sediment samples which may be required, such devices may prove efficient and effective for difficult terrain/remote locations. Sampling devices should be cleaned in the field using the decontamination procedure described in the Sampling Equipment Decontamination SOP FLD 02.00.

### **11.2 Preparation**

Determine the objective(s) and extent of the sampling effort. Obtain access to private property if sample locations are located within private boundaries. The sampling methods to be employed, and the types and amounts of equipment and supplies required will be a function of site characteristics and objectives specified in the SAP and QAPP.

- Obtain the necessary sampling and monitoring equipment.
- Prepare schedules, and coordinate with staff, client, and regulatory agencies where appropriate.
- Decontaminate or pre-clean equipment, and ensure that it is in working order.

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- Perform a general site survey prior to site entry in accordance with the site-specific HASP.
- Use stakes, flagging, or buoys in addition to using a GPS (Refer to SOP FLD 07.00) to identify and mark all sampling locations. Specific site factors including flow regime, basin morphology, sediment characteristics, depth of overlying aqueous layer, contaminant source, and extent and nature of contamination should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

### **11.3 Sample Collection**

Selection of a sampling device is most often contingent upon the depth of water at the sampling location and the physical characteristics of the sediment to be sampled. The following procedure consists of sampling surface sediment with a scoop, trowel or shovel from beneath a shallow aqueous layer:

For the purpose of this method, surface sediment is considered to range from 0 to 1 inch in depth and a shallow aqueous layer is considered to range from 0 to 12 inches in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with tools such as spades, shovels, trowels, and scoops. Although this method can be used to collect both unconsolidated/consolidated sediment, it is limited somewhat by the depth and movement of the aqueous layer. Deep and rapidly flowing water may render this method less accurate than other methods such as utilizing a handheld dredge or coring device. However, representative samples can be collected with this procedure in shallow sluggish water provided care is demonstrated by the sample team lead. A plastic scoop will suffice in most applications. Care should be exercised to avoid the use of devices plated with chrome or other materials.

The following procedure will be used to collect sediment with a scoop, shovel, or trowel:

1. Using a decontaminated sampling implement, collect the desired thickness and volume of sediment from the sampling area.
2. Transfer the sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.
3. Surface water should be decanted from the sample or homogenization container prior to sealing or transfer; care should be taken to retain the fine sediment fraction during this procedure.

#### **11.3.1 Composite Sampling**

Composite sampling consists of taking several sub-samples from a location and consolidating them into a larger sample. If data quality objectives dictate that each sub-sample of a composite be measured, it can be done two ways; by mass or by volume. For remote site field sampling activities (such as ones that typically occur in Region 8), it is

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recommended that sub-samples be measured by volume. This can be done with a graduated beaker/measuring cup or cylinder. Place the sub-sample in the measuring device, record the measurement, and transfer the sub-sample into a larger container where the complete composite sample will be processed.

Composite representative sample collection can also be accomplished without measurement of sub-samples. For sediment collection that does not require sub-sample measurement, larger amounts of sample can be collected in areas where sediment is more readily available. This method is used very frequently in high-gradient streams such as those found in the region.

### **11.3.2 Discrete Sampling**

Discrete sampling consists of taking a sample from a single location. This method requires that the selected location for a sediment sample have sufficient amount of material for the analytical requirements. In general, sediment samples in a stream are difficult to obtain from a single location; therefore composite samples are more commonly collected.

## **12.0 DATA RECORDS AND MANAGEMENT**

Once collected, samples are labeled and stored for transport (at 4°C). A COC must accompany all samples during transport and transfer between entities. Sample labels should contain the following information:

- Site Identification
- Date sampled
- Sampler initials
- Time
- Analysis to be performed

## **13.0 QUALITY CONTROL AND ASSURANCE**

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the SAP and QAPP. Equipment inspection must occur prior to sampling, and they must be documented.
3. QA samples should be sampled at a standardized frequency. Field duplicates are generally sampled at a rate of 1:20.

## **14.0 REFERENCES**

EPA Guidance for Preparing Standard Operating Procedures, EPA QA/G-6, April 2007.

Mason, B.J., Preparation of Soil Sampling Protocol: Technique and Strategies. 1983 EPA-600/4-83-020.

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de Vera, E.R., B.P. Simmons, R.D. Stephen, and D.L. Storm. Samplers and Sampling Procedures for Hazardous Waste Streams. 1980 EPA-600/2-80-018.

U.S. EPA, Environmental Response Team, standard operating procedures—Sediment Sampling: U.S. Environmental Protection Agency, 1994, SOP #2016.

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**Table 9.0-1: Sediment Sampling Equipment**

<u>Category</u>	<u>Item</u>	<u>Use</u>	<u>Comment</u>
Health and Safety	Gloves	Protection from absorption of contaminants	Nitrile or neoprene are recommended
Health and Safety	Waders	Slip/contaminant protection	Any type are acceptable
Health and Safety	Safety Glasses	Eye protection	Sunglasses for UV protection
Health and Safety	Layered Clothing	Protection from hypothermia	Polyester base layers only
Mapping/Location	GPS unit	Sample station locating	Pre-loaded with site locations
Mapping/Location	Maps	Location identification	Must contain most current information
Mapping/Location	Two-way radios	Communication	Extra batteries or charger required
Documentation	Field Logbook	Site data and conditions documentation	Waterproof pages
Documentation	Chain of Custody	Sample handling/identification	Pre-printed using Scribe
Documentation	Labels	Sample identification	Pre-printed using Scribe
Documentation	Clear tape & Scissors	Label protection	
Sampling Tools	Bucket/Transfer Device	Sample transfer (if required)	Can also be used for sample homogenization
Sampling Tools	Sediment Scoop	Sediment sampling	Select based on analysis
Sampling Tools	Cooler	Sample containment	Cool to 4 °C
Sampling Containers	Amber glass jars	Volatile Organics Analysis sample containment	Tight cap seal
Sampling Containers	50 ml HDPE (widemouth)	Metals analysis sample containment	
Reagents	10% Nitric Acid (HNO <sub>3</sub> ) solution	For decontamination of metals sampling equipment	Pre-mixed at lab
Reagents	10% Hydrochloric Acid (HCl) solution	For decontamination of organics sampling equipment	Pre-mixed at lab

Effective Date: 3/30/2012

Replaces SOP: N/A

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**Global Positioning System (GPS) -  
Trimble GeoXT 2008 Series**

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**APPROVED:**

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Date

DCN: EP8-6-6513

This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

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## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standard approach for United States Environmental Protection Agency (EPA) and Environmental Services Assistance Team (ESAT) Region 8 personnel to use a Global Positioning System (GPS) during field activities.

## 2.0 SCOPE AND APPLICATION

This SOP is specifically intended for application by EPA and ESAT personnel who conduct field work using a GPS.

## 3.0 SUMMARY OF METHOD

This SOP covers the use of TerraSync on Trimble GeoXT 2008 Series GPS machines as well as the Laser RangeFinder and Pathfinder Office. This SOP is based on manufacturers' instructions.

## 4.0 ACRONYMS AND DEFINITIONS

EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
GIS	Geographic Information System
GPS	Global Positioning System
HASP	Health and Safety Plan
SOP	Standard Operating Procedure

Geographic Information System (GIS): A system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data.

Global Positioning System (GPS): A navigational system involving satellites and computers that can determine the latitude and longitude of a receiver on Earth by computing the time difference for signals from different satellites to reach the receiver.

Terrasync: Software used in GPS units that captures and stores spatial data collected in the field.

Trimble: A private GPS Company that provides equipment and technical support, including the 2008 GeoXT GPS units and TerraSync software.

## 5.0 HEALTH AND SAFETY

There are no health and safety issues requiring mention in this SOP; however, refer the applicable site-specific Health and Safety Plan (HASP) any time field work is conducted.

## 6.0 EQUIPMENT

Trimble GeoXT 2008 Series GPS unit with TerraSync  
LTI TruPulse 360 Laser RangeFinder  
TruPulse 200B/36B Cheat Notes card  
Tape measure

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Replaces SOP: N/A

Flags  
Computer and/or external hard drive

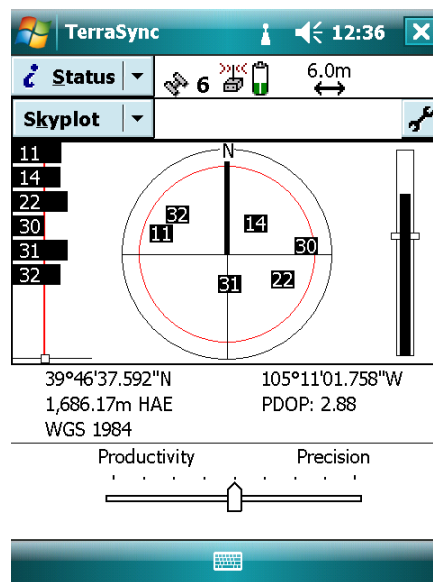
## 7.0 TERRASYNC

### 7.1 Starting TerraSync



To begin, press the green button on the Trimble unit. Tap **Start**, then **TerraSync** to open the GPS application (left). If not available, tap **Programs**, then select **TerraSync**.

TerraSync will open with the **Status-Skyplot** page and begin to acquire satellite information. A minimum of four satellite locks are necessary to obtain a position. More satellites and proper satellite geometry increase accuracy.



## 7.2 TerraSync Setup Menu

As TerraSync begins to acquire satellites, make sure the unit is properly configured. Tap the upper drop down menu and choose **Setup**. From the **Setup** page, tap **Coordinate System** and ensure that your screen matches the figure below. If a different coordinate system is required, use the dialog shown below to make necessary changes. Keep defaults if unsure. Select **OK** to return to setup menu.

The screenshot shows the 'Coordinate System' dialog box in the TerraSync application. At the top, there are 'OK' and 'Cancel' buttons. Below them, the text 'Select By: Coordinate System and Zone' is displayed. The 'System:' dropdown menu is set to 'Latitude/Longitude'. The 'Datum:' dropdown menu is set to 'NAD 1983 (Conus)'. The 'Altitude Reference:' dropdown menu is set to 'Mean Sea Level (MSL)'. The 'Altitude Units:' dropdown menu is set to 'Feet'. A keyboard icon is visible at the bottom of the dialog.

Next, choose **Real-Time Settings**. These settings will allow you to receive real time differentially corrected readings from satellite-based radio transmitters, if available. If not available, you will be using uncorrected GPS signals that can be corrected later by ESAT Region 8 GIS personnel. Please ensure that your screen matches the figure on the right. Select **OK** to return to setup menu.

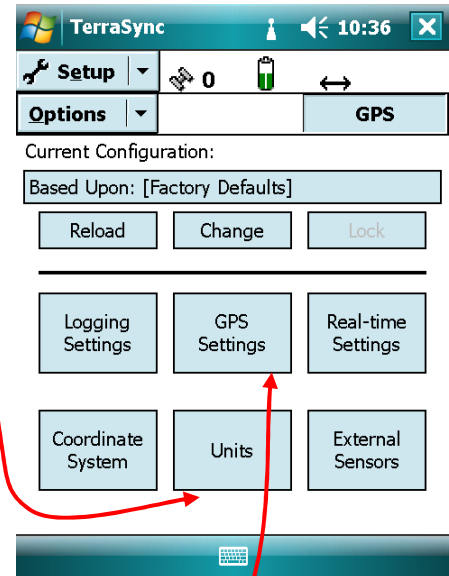
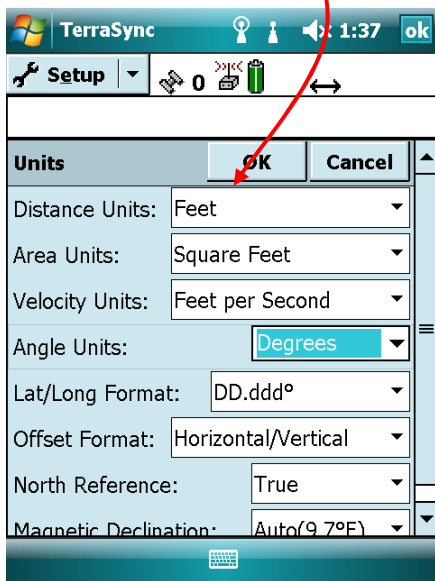
The screenshot shows the 'Setup' menu in the TerraSync application. At the top, there is a 'Setup' dropdown menu and a 'GPS' button. Below them, the text 'Current Configuration:' is displayed. Under this, there is a 'Based Upon: [Factory Defaults]' label and three buttons: 'Reload', 'Change', and 'Lock'. Below these are six buttons arranged in two rows: 'Logging Settings', 'GPS Settings', 'Real-time Settings' in the first row, and 'Coordinate System', 'Units', 'External Sensors' in the second row. A keyboard icon is visible at the bottom of the screen.

The screenshot shows the 'Real-time Settings' dialog box in the TerraSync application. At the top, there are 'OK' and 'Cancel' buttons. Below them, 'Choice 1:' is set to 'Integrated SBAS'. 'Choice 2:' is set to 'Use Uncorrected GPS'. The 'Real-time Age Limit:' is set to '1 min'. A keyboard icon is visible at the bottom of the dialog.

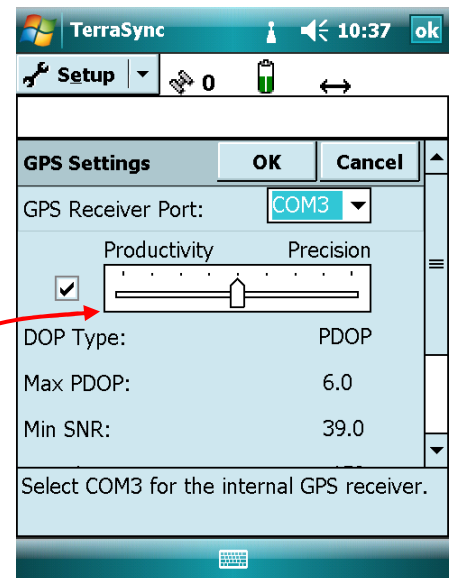
Effective Date: 3/30/2012

Replaces SOP: N/A

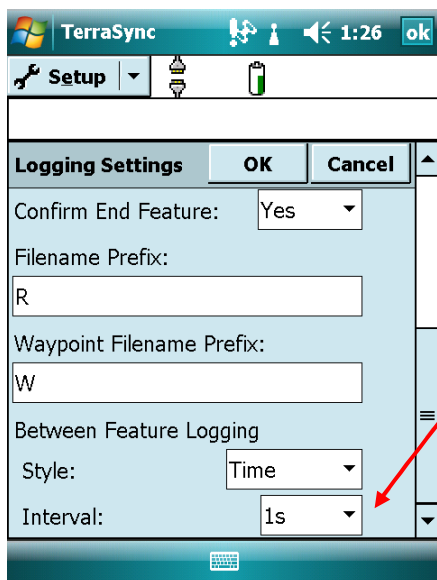
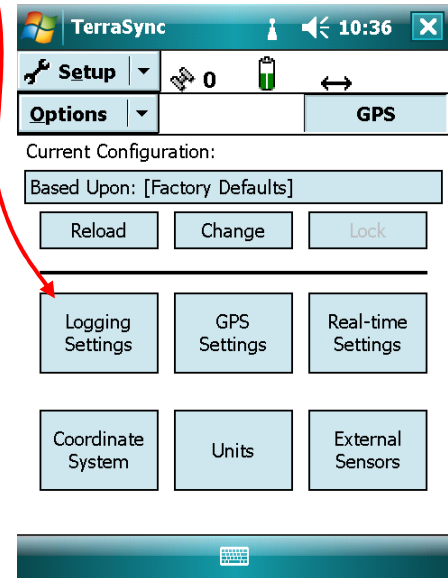
The **Units** menu allows you to choose which units will be used for display in the **Map** section (feet). Make any necessary changes. Select **OK** to return to setup menu.



Under the **GPS Settings** menu, you can control the level of accuracy that your unit measures by adjusting the slider bar. Keep the defaults unless you are sure that you are willing to sacrifice precision for productivity or vice versa. Make sure that the **Productivity/Precision Bar** is set in the middle to give you a PDOP of 6.0, a minimum SNR of 39, and a minimum elevation of 15 degrees. Keep the settings for Velocity Filter and NMEA Output set to "Off." Select **OK** to return to setup menu.



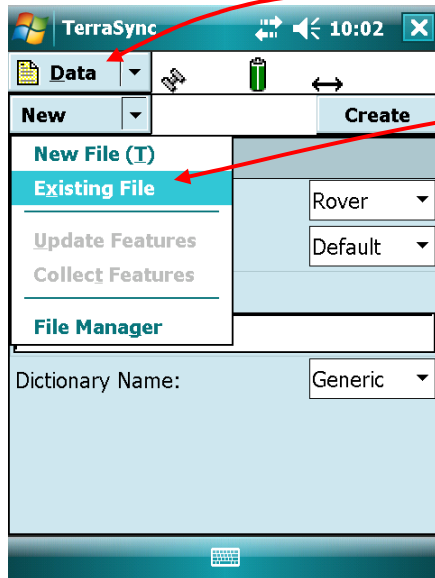
The **Logging Settings** menu allows you to adjust how you will log your data. In this dialog box, you will set your logging interval to either 1 or 5 seconds, depending on the data being collected (the default used by ESAT is 1 second; however, 5 seconds is better suited for high volume data collection, such as a large polygon or area). You will also set your antenna height to the height at which you will be collecting your data. Normally, this will be set at 1 meter (approximately 3.5 feet or the height an average person would hold the unit). If you wish to change Antenna Height, click the following icon located just right of the Antenna Height figure:



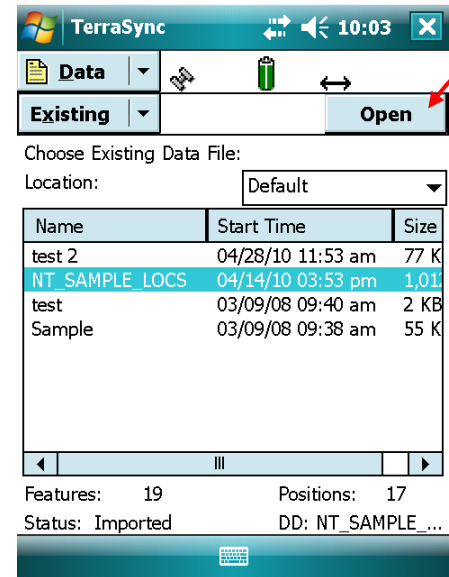
Effective Date: 3/30/2012

Replaces SOP: N/A

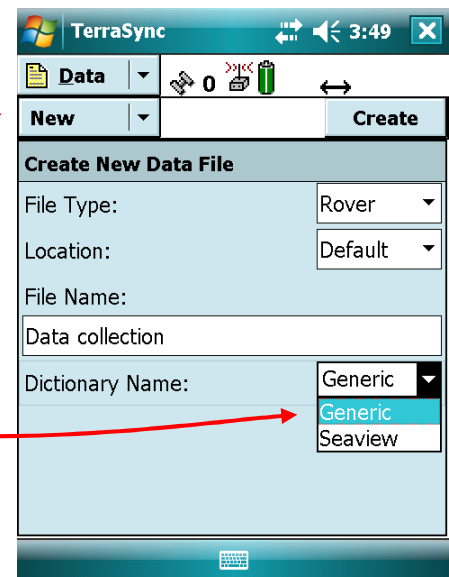
### 7.3 TerraSync Data Menu



Select **Data** from the main drop down menu. The default will be to create a new data file. Click the drop down labeled **New** and choose **Existing File**. From this menu, select the appropriate file and click on the **Open** button. Then confirm antenna height.



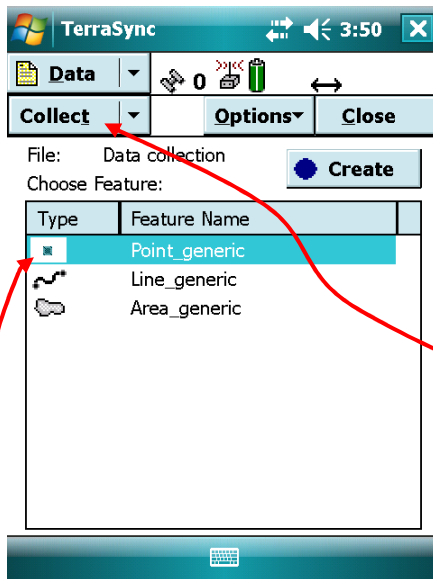
If you wish to create a new file or cannot find the appropriate existing file, click the **New** tab. Rename the new file to a project specific name. Select the proper data dictionary. Choose **Generic** if a data dictionary does not exist for your project. Tap **Create** and confirm antenna height at 1 meter (~3.5 feet) in subsequent pop-up.



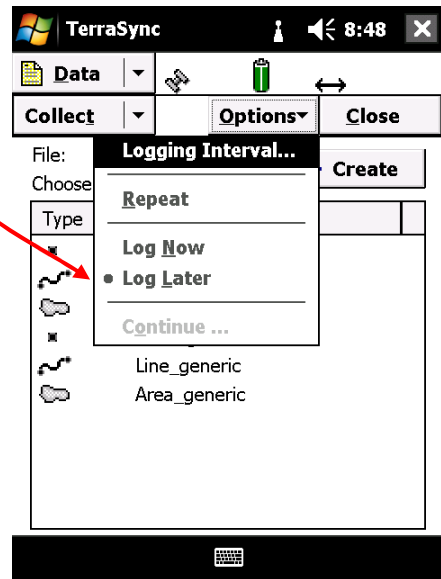
Effective Date: 3/30/2012

Replaces SOP: N/A

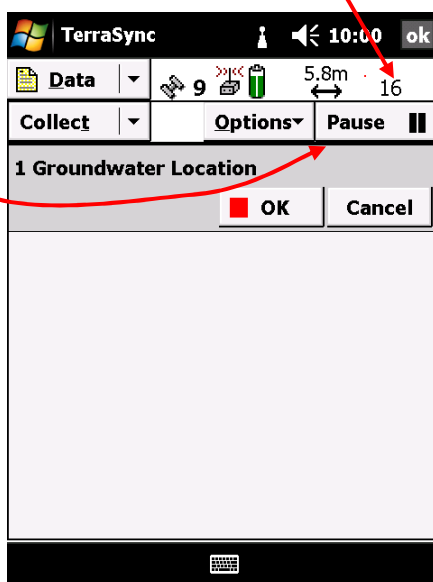
The features you are able to collect are now available in a list (below left). Click the **Options** tab and select **Log Later**. Use the **Options** tab to select a logging interval appropriate for the type of data you are collecting (below right).



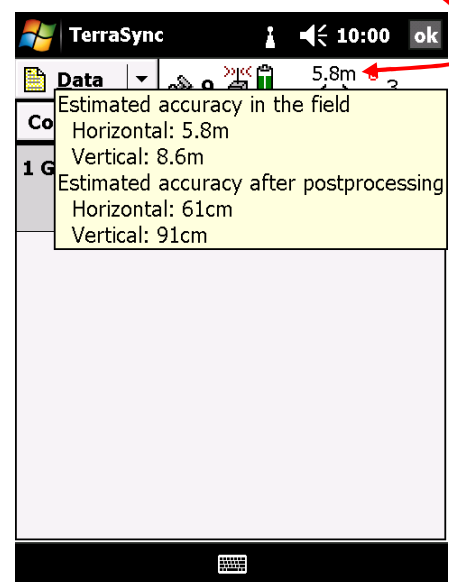
Ensure that this Tab has **Collect** selected.



Select **Point**, **Line**, or **Area**, then tap the **Create** button. When ready to collect data, tap the **Log** button (button will show pause if not currently logging, as shown here). Attribute any and all necessary fields (tap keyboard icon to enter description). This can be done before, during, or after collecting your data. Make sure to collect at least 30 positions for each point. Your positions count is displayed above the **Log** button.



Estimated accuracy is listed here. By tapping this number more detail will be shown (right).

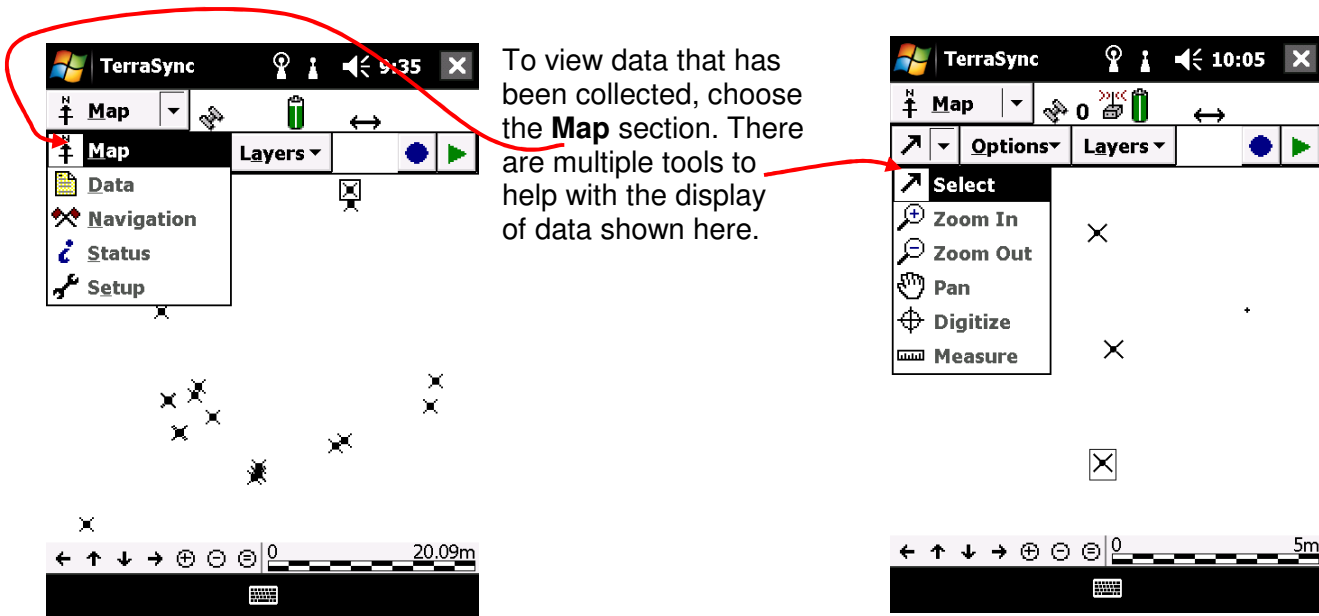


Effective Date: 3/30/2012

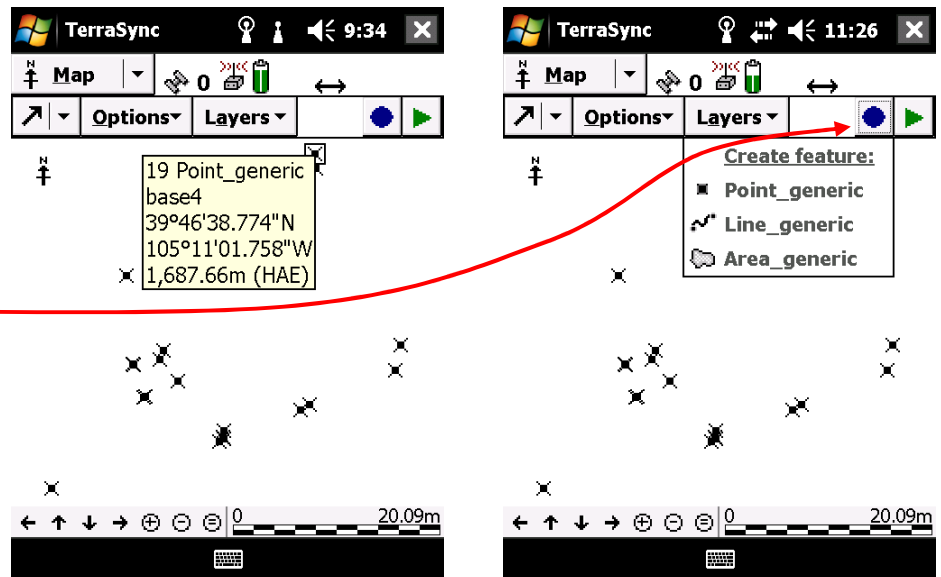
Replaces SOP: N/A

When ready, click **OK** to finish feature collection. You will be returned to the main data collection page. Continue collecting data until finished. Data will be saved as you go. When finished with data collection, exit out of TerraSync and turn off unit (Green button).

## 7.4 TerraSync Map Menu



Tapping any point will display the attributes of a point, including a point's latitude and longitude. Logging GPS positions can be accomplished in the **Map** section. After selecting and setting up the proper data file in the **Data** section, choose **Map**. Tap **Create Feature** button, then tap the arrow key on the top right to begin logging points. When enough points have been collected, click **Ok**.

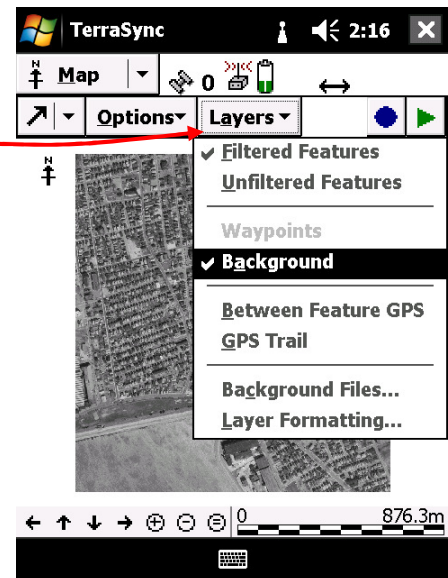




Effective Date: 3/30/2012

Replaces SOP: N/A

The on-screen display in the **Map** section can be enhanced with an aerial or topographical image. This must be set up prior to field collection with ESAT. If available select **Layers** and tap **Background** to enable the image (See Below).

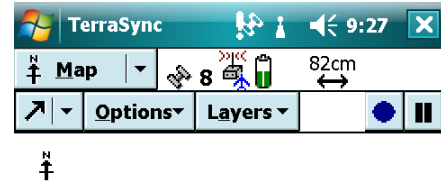
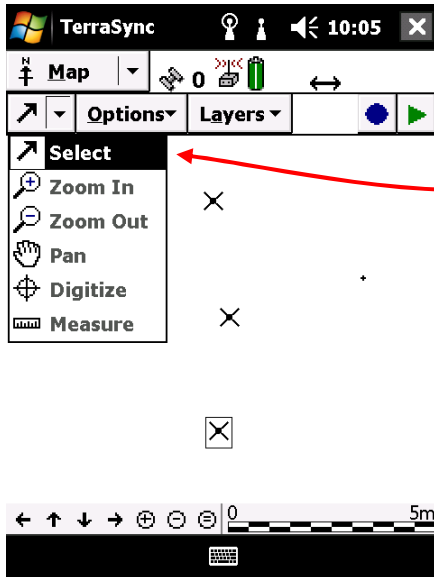


Effective Date: 3/30/2012

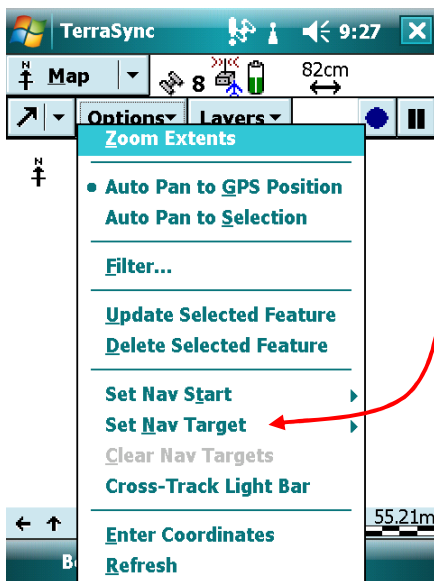
Replaces SOP: N/A


## 7.5 Navigation Using TerraSync

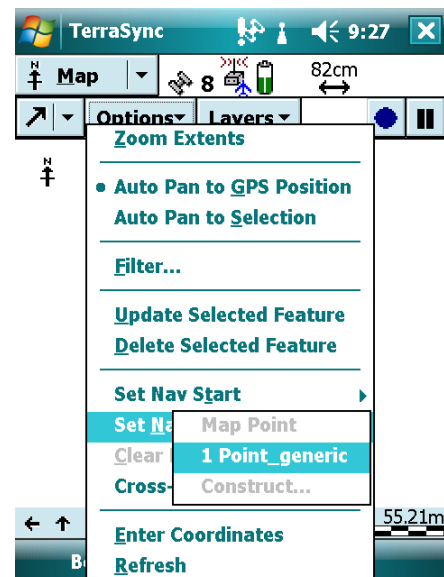
TerraSync and your Trimble unit can help you to navigate to a specific point if that point has already been loaded into the data. In the **Map** tab, use the selection arrow to select the point of interest (below, right).



1 Point\_generic  
 GL-01  
 39.77710911°N  
 105.18386480°W  
 1,693.88m (HAE)



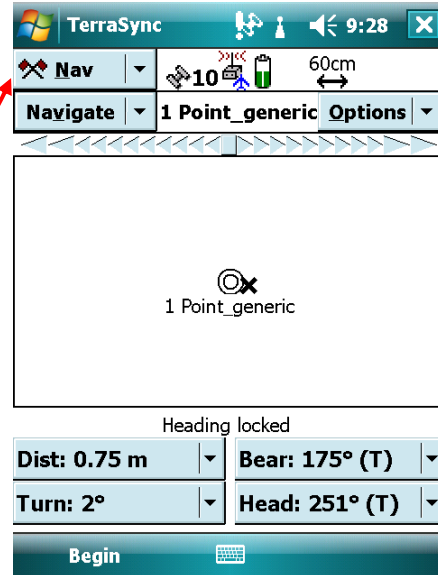
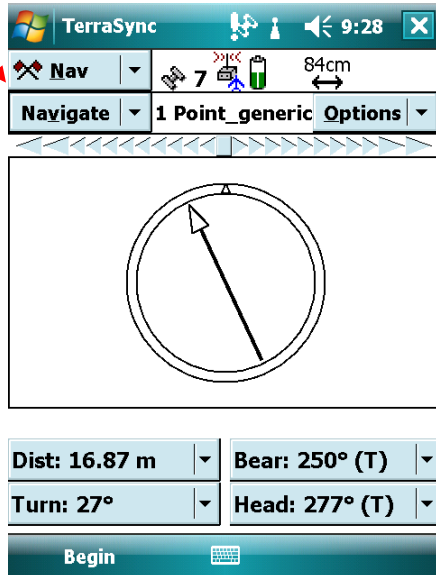
Tap the **Options** tab and then select **Set Nav Target**. Next, select the highlighted feature in the drop down menu (below). On the map, the point you are navigating to will have a crossed flag symbol like this: 



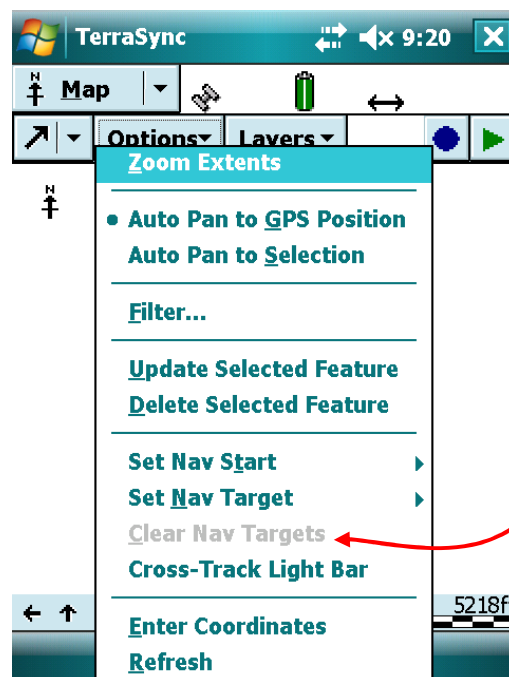
Effective Date: 3/30/2012

Replaces SOP: N/A

Once you have selected the point feature of interest, you can switch to the **Nav** menu on the main drop down list (left). The arrow guides you in the direction of the point of interest giving distance and bearing. You have to be moving for this to work. This navigation menu will change once you are close (right). You are the **X**.



Once finished navigating, go back to the **Map** section by going to the **Nav** menu and clicking **Map**. In the **Map** section, click **Options** and select **Clear Nav Targets**.



## 8.0 LASER RANGEFINDER

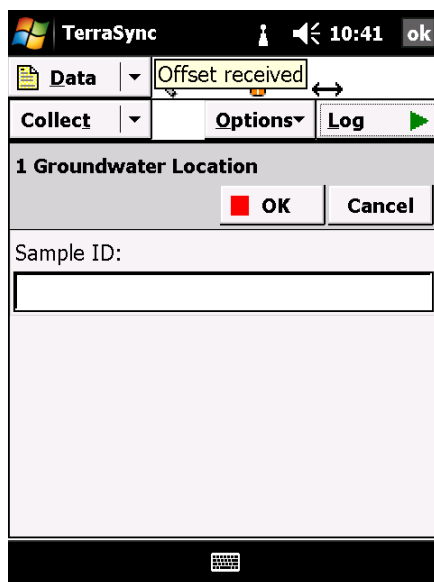
The LTI TruPulse 360 Laser RangeFinder is a measurement device that emits a laser to a distance of up to 1,000 meters and returns various information, such as vertical distance, horizontal distance, slope distance, inclination, azimuth, and height.

### 8.1 Enabling the Laser RangeFinder for Offset Point Collection

The Trimble units have been configured with the Laser setup and are ready to work. Laser #1 is setup for GPS units 1 & 2. Laser #2 is setup for GPS units 3 & 4. Before using the laser on your GPS device, you need to turn on Bluetooth on the Laser Rangefinder. To do this, look into the Laser eye piece and turn on the laser by clicking the **FIRE** button on top of the laser. Press the down arrow for four seconds. Press the down arrow once to get to the Blue Tooth option. Select **FIRE**. You have now enabled Blue Tooth on the laser. It should read **Bt\_on**. Press **Fire** to return to main menu. Once the laser is enabled, it should be ready to work when you open a data file in the **Data** section of TerraSync.

### 8.2 Using the Laser RangeFinder in TerraSync

To use the laser once setup is complete, follow the same steps in data collection and begin logging points. After naming your sample ID, begin logging points. Aim the Laser RangeFinder at your target and push the **FIRE** button. You will be given notice that the offset has been received. Make sure that the **Offset received** notification appears. Sometimes your laser shot will not register and you will need to repeat your shot. When finished with the laser, it will turn off by itself.

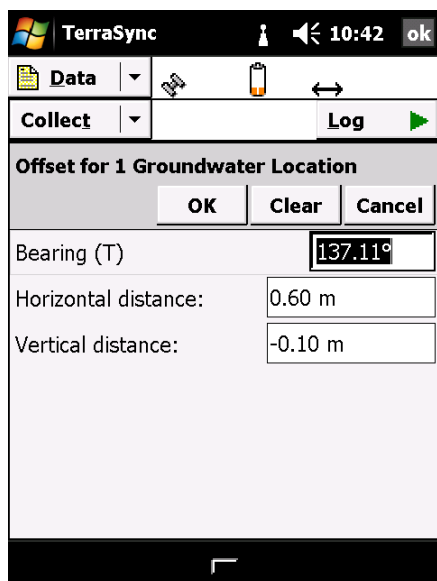
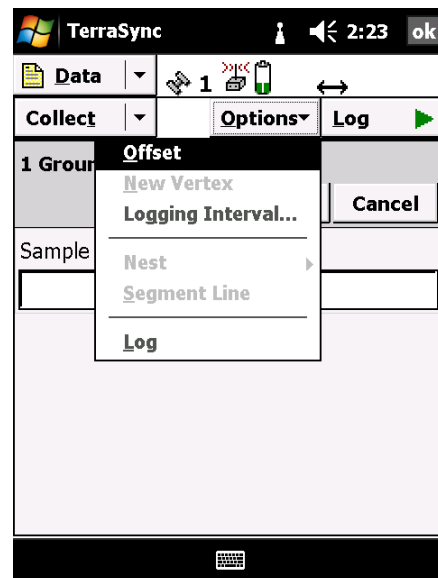


**REFER TO SECTION 8.3 TROUBLESHOOTING THE LASER RANGEFINDER IF YOU EXPERIENCE ANY DIFFICULTIES IN THE SETUP PROCESS.**

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Replaces SOP: N/A

To confirm the offset distance, you can tap the **Options** button and then click **Offset** to view the offset information that has been gathered.



Your offset has been captured. Click **OK** and then click **OK** again to capture the offset point.

For additional setting and configuration options for the laser, refer to the TruPulse 200B/36B Cheat Notes card. This card can be found in the Laser Box.

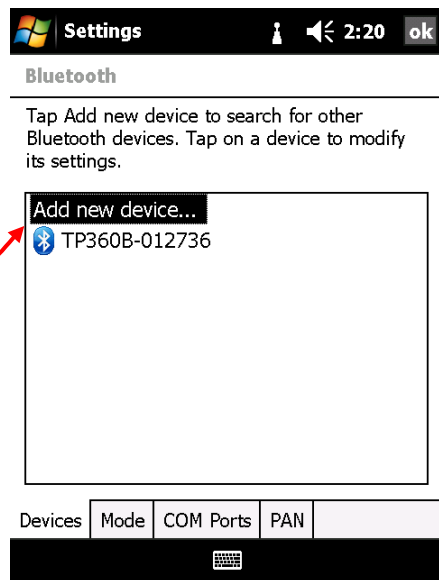
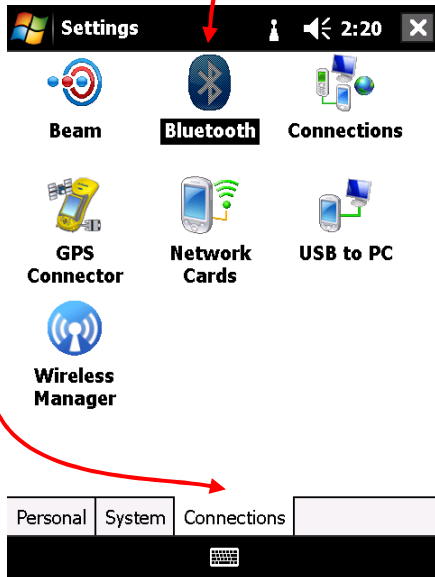
### 8.3 Troubleshooting the Laser RangeFinder

If enabling the laser did not work as described above, you will have to reestablish and reconfigure the Bluetooth connection to the Trimble unit. This is common so do not panic! At times, this process may seem to loop on itself. Follow these instructions and you will be ready to use the laser in very little time.

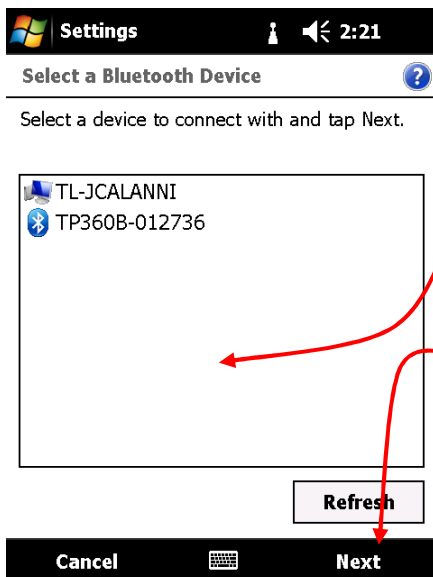
Effective Date: 3/30/2012

Replaces SOP: N/A

First ensure that the laser's Bluetooth is turned on.  
To activate the laser on your GPS device, tap **Start** and select **Settings**. At the bottom of the **Settings** page, select the **Connections** tab, then tap the **Bluetooth** icon.



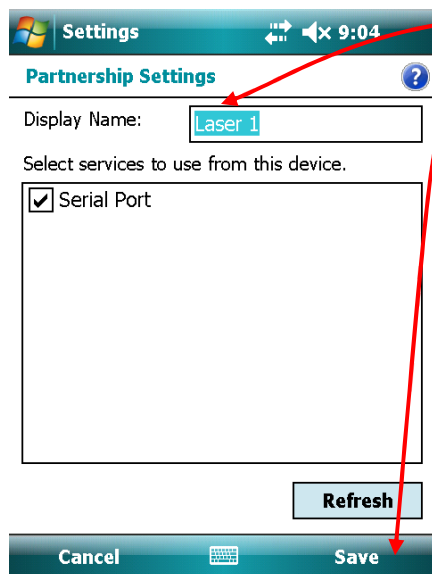
Choose **Add new device**.



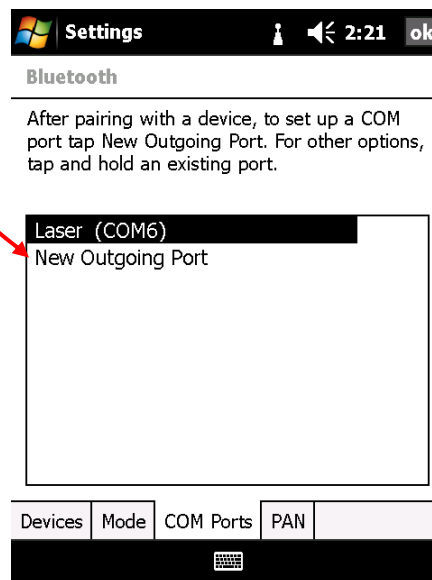
Select the Bluetooth Icon with label TP360B-012736. This number code is for Laser 1 (used with GPS unit 1 and 2); if using Laser 2 (for use with GPS units 3 and 4) the number code will be TP360B-017564. Tap **Next**. You will be prompted to enter the following pass code: 1111

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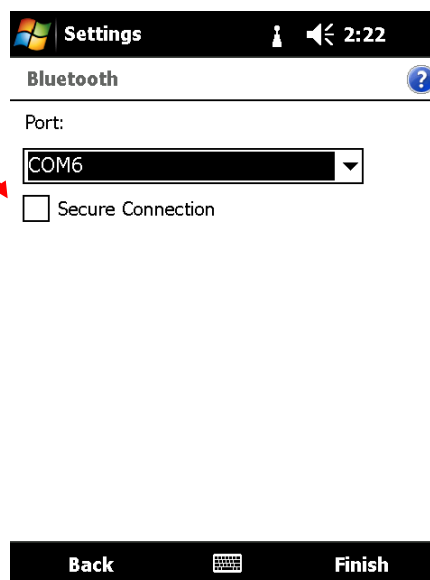
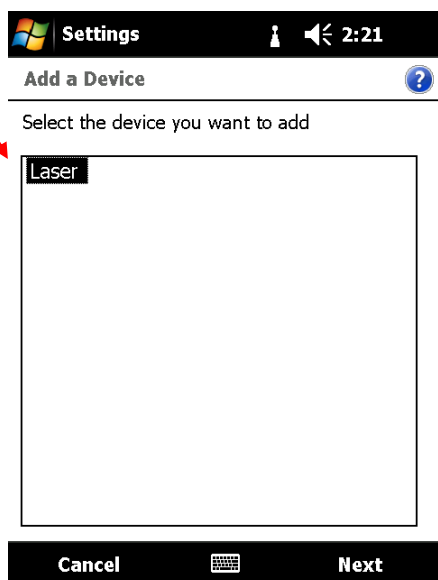
Replaces SOP: N/A



Check **Serial Port**, rename the **Display Name** "Laser," and click **Save** (left). In the next screen, choose **COM Ports** and select **New Outgoing Port**.

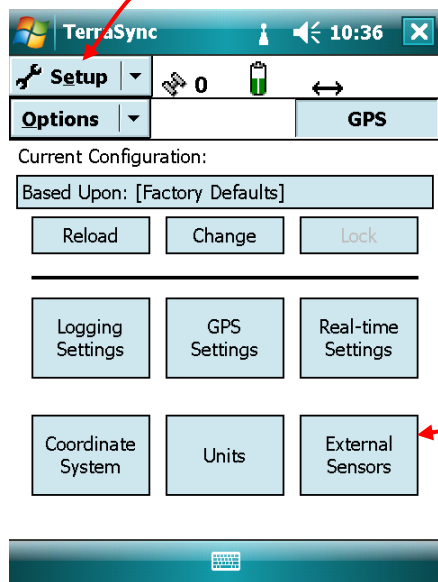


Select **Laser** and tap **Next**. On the next screen, choose a COM Port from the drop down. **Do not check Secure Connection**. Tap **Finish**. Close this application.



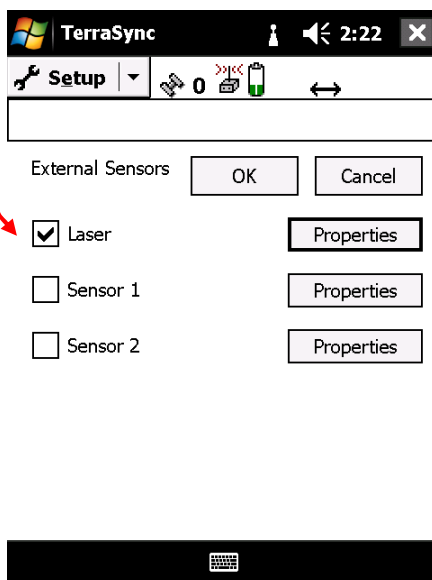
Effective Date: 3/30/2012

Replaces SOP: N/A



Back in TerraSync, tap the **Setup** menu and choose **External Sensors** to link to the Laser Rangefinder.

Check the box next to **Laser** to enable. Next tap the **Properties** box to setup the correct COM Port.

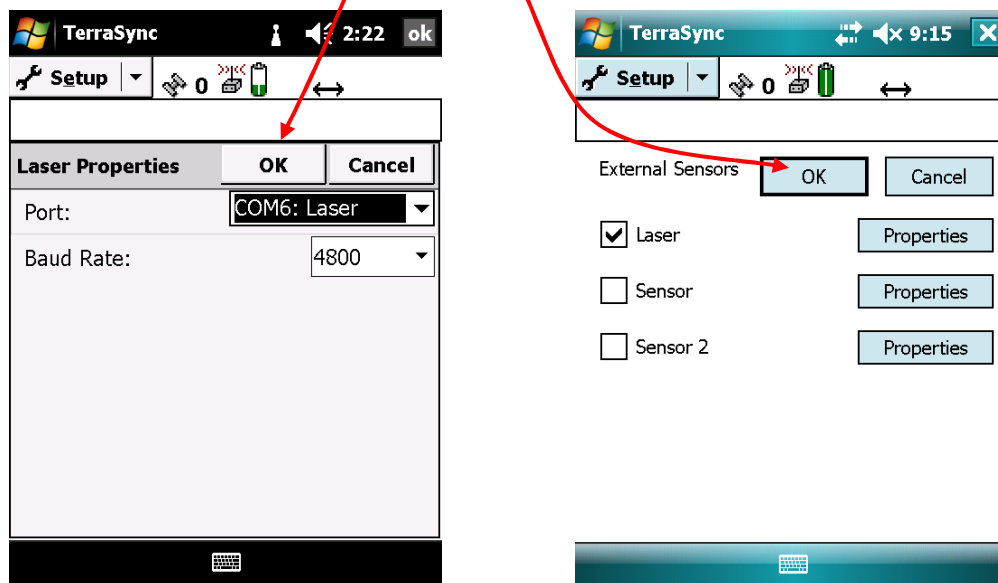




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Replaces SOP: N/A

Tap the drop down box next to **Port** and choose the COM Port that you assigned to the **Laser**. Tap **OK** and then tap **OK** on the next screen. You are now ready to take offset points using the Laser Rangefinder.



## 9.0 TROUBLESHOOTING

Sometimes the units go into deep hibernation and will not turn on using the on/off button. To fix this, the power button and tiny grey reset button need to be depressed simultaneously. Use a pen to press the reset button (inset on the upper left of the Trimble keypad).

### 9.1 Contact numbers for assistance

Ryan Bahnfleth, ESAT	303.312.7723
Dan Michor, ESAT	303.312.7715
Trimble Support	1.800.728.5066

## 10.0 REFERENCES

Trimble Navigation Limited. Trimble Mapping and GIS Products: New Post-Processing Engine. 2009. Westminster, CO, USA.

Trimble Navigation Limited. TerraSync Software Reference Manual. 2008, Version 3.21, Revision A. Westminster, CO, USA.

Trimble Navigation Limited. GeoExplorer 2008 Series User Guide. 2008, Version 1.00, Revision B. Westminster, CO, USA.

Effective Date: 3/30/2012

Replaces SOP: N/A

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## FlowTracker® Operation

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### APPROVED:

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EPA Task Order Project Officer

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ESAT Region 8 Task Lead

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Date

DCN: EP8-6-6513

This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

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## 1.0 GETTING STARTED: OPERATIONAL OVERVIEW

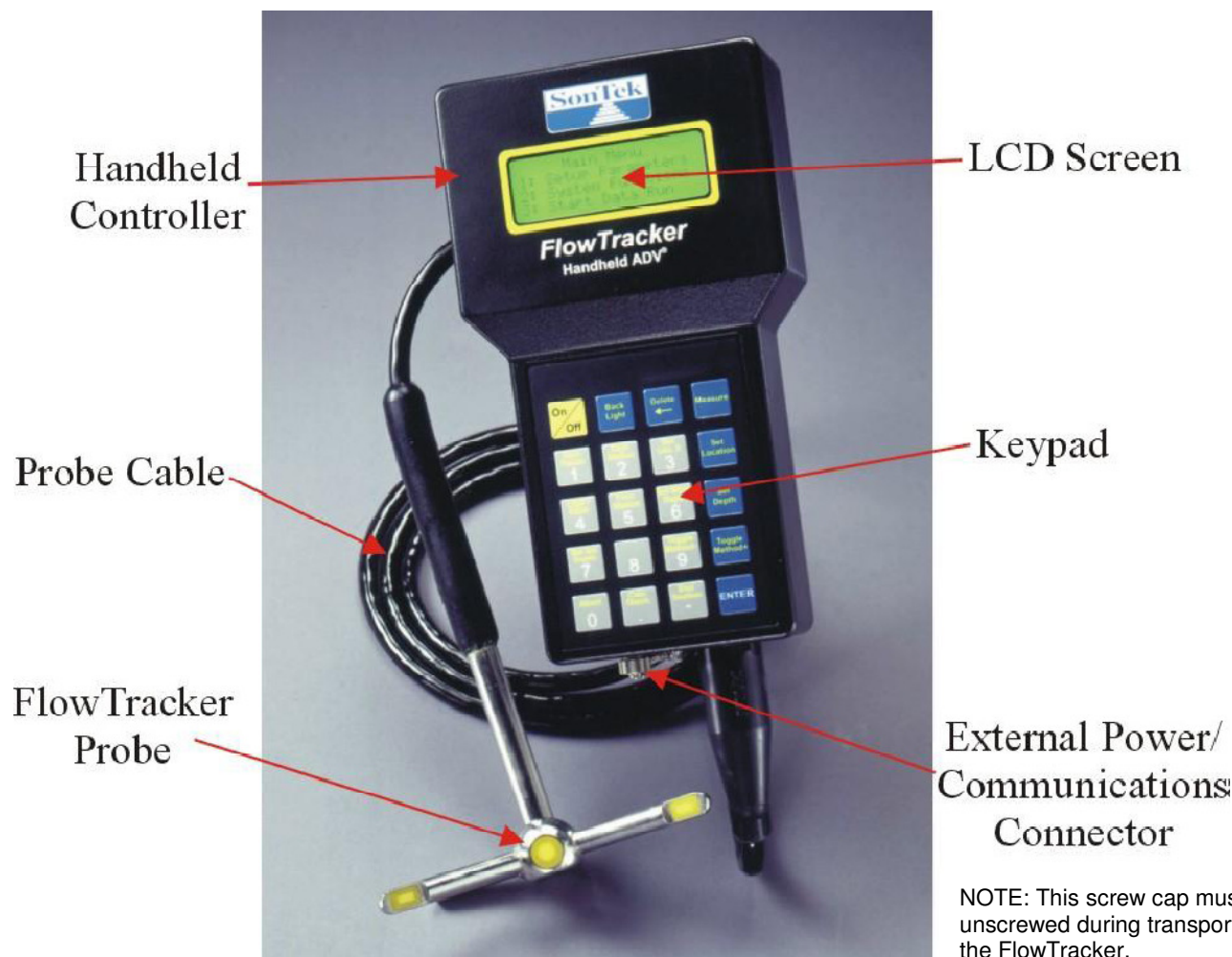


Figure 1.0-1 – FlowTracker with 2D Probe

### 1.1 System Components

#### 1.1.1 Figure 1.0-1 Flow Tracker with 2D Probe

Figure 1.0-1 shows the FlowTracker with all major components labeled.

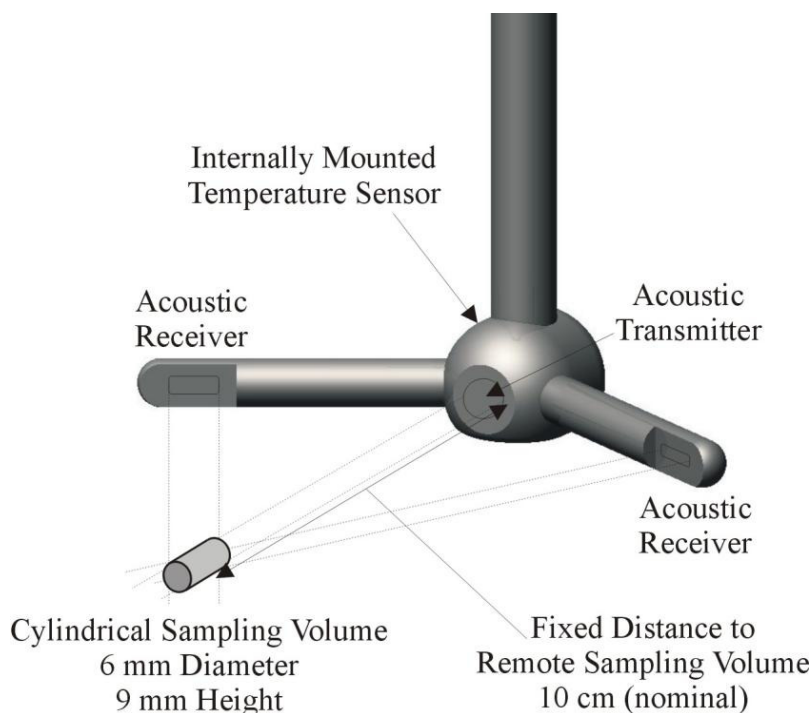
- **Probe** – The probe contains the acoustic elements used to measure velocity. See the *FlowTracker Principles of Operation* for more information.
- **Probe cable** – The probe is mounted from a 200-cm (80-in) flexible cable. The probe cable is custom built and highly noise-sensitive; it must never be modified.

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- **Handheld controller** – The handheld controller contains the processing electronics, batteries, keypad, and liquid crystal display (LCD) screen. The controller is designed to withstand temporary submersion, but is not intended for underwater operation.
- **Keypad** – The FlowTracker keypad is designed for quick, efficient entry of data collection parameters and commands.
- **LCD screen** – The LCD screen displays instructions and real-time data.
- **External power/communication connector** – A waterproof connector on the bottom of the handheld controller connects to an external power/communication cable. This is used to download data from the FlowTracker to a personal computer (PC). During data collection, the connector is sealed with a dummy cap. **WHEN TRANSPORTING FLOWTRACKER, THIS SCREWCAP MUST BE UNSCREWED.**

1.1.2 Figure 1.0-2 2D Side Looking FlowTracker Probe and Sampling Volume



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## 2.0 ACRONYMS AND DEFINITIONS

°C	Degrees Celcius
°F	Degrees Fahrenheit
%Q	Section Discharge
$\sigma V$	Standard error of velocity
Bnd	Boundary QC variable
cfs	Cubic feet per second
cm	centimeter
dB	Decibel
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
ft	feet
ft/s	feet per second
Hz	Hertz
in	inch
LCD	Liquid Crystal Display
m	meter
mA	Milliampere
MB	Megabyte
m/s	Meters per Second
PC	Personal Computer
ppt	parts per thousand
QC	Quality Control
SNR	Signal-to-Noise Ratio

Averaging time: The time (in seconds) in which the FlowTracker records data at each measurement location. This is a United States Geological Survey specified value of 40 seconds (Blanchard, 2004).

External control: The FlowTracker can be controlled by an external computer using the RS232 serial interface. This is accessed from the external power/communication connector. External control is used to download data from the internal recorder to a PC for further analysis, display, and archiving.

Keypad interface: The FlowTracker is controlled from the keypad on the handheld controller. The LCD screen is used to display command options and real-time data.

Measurement location: At each measurement location, the FlowTracker records one second velocity data for the specified averaging time, location, and water depth parameters (to document the data set), and a variety of statistical and quality control data.

Ping: A single estimate of the 2D or 3D water velocity.

Ping rate: The number of pings per second (Hz). The FlowTracker ping rate is 10 Hz.

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Quality control data: In addition to velocity, the FlowTracker records several quality control (QC) parameters. These include signal-to-noise ratio (SNR), standard error of velocity, boundary adjustment, the number of spikes filtered from data, and velocity angle.

Salinity: Water salinity (in ppt) is a user-supplied value that is used for sound speed calculations. Note: If using the system in salt water, a zinc anode should be installed on the probe for corrosion protection.

Sample: A sample refers to the mean of 10 pings to produce a measurement of the 2D or 3D water velocity. A sample includes velocity and signal strength data. The FlowTracker records one sample per second.

Signal strength: This refers to the strength of the reflected acoustic signal. It is a function of the acoustic conditions of the water – primarily the amount and type of suspended material (scatterers) present. This is most commonly accessed as a SNR.

Signal-to-noise ratio (SNR): SNR is the ratio of the received acoustic signal strength to the ambient noise level. It is expressed in logarithmic units (dB) and is the most important QC data for the FlowTracker.

Sound speed: Speed of sound in water (in m/s) is used to convert the Doppler shift to velocity.

Temperature: Water temperature (°C) is measured by the internal temperature sensor. Temperature is used for sound speed calculations.

### 3.0 USING THE KEYPAD INTERFACE, MENUS AND DISPLAY

This section describes FlowTracker's keypad interface, its menus, and the LCD display.

#### 3.1 On/Off Switch

The **On/Off** power button is in the upper left hand corner of the keypad.

- To turn the system on, hold the button for one second until the LCD screen turns on.
- To turn the system off, hold the button for four seconds until the LCD screen resets.
- The FlowTracker draws a small amount of current when off (< 1 mA). If the system is to be left idle for a long period (more than 1 month), remove the batteries to prevent unnecessary draining and potential battery leakage.

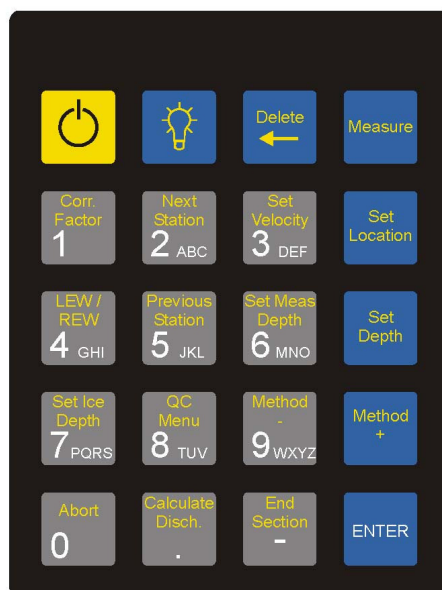
**NOTE:** *It is important to always return to the Main Menu before turning the system off to ensure all data has been properly saved.*

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## 3.2 Keypad

### 3.2.1 Figure 2.2-1 – FlowTracker Keypad



The function of each key is described below. Many keys have multiple functions.

Keys are described starting at the top left, moving right and down by rows.

#### Numbers (0-9)

- These keys are used to enter the following information when prompted by the FlowTracker: Menu selections, filename and extension, station location, depth, and other information.

#### Letters (A-Z)

- These keys are used to enter text for the filename and for comments in the file.
- Text entry is done in the same manner as for mobile phones. For file names, the text entry assumes numbers first (i.e., for “C” press 2 button four times 2 – A – B – C); for all other text, it assumes letters first (i.e., for “C” press 2 button three times A – B – C).

**NOTE: It is important to always return to the Main Menu before turning the system off to ensure all data has been properly saved.**

#### Backlight

This key turns the LCD backlight on/off.

- If the backlight is already on, it turns the backlight off.
- The backlight will turn off automatically after 1 minute.
- Minimize backlight use to increase battery life (the backlight doubles power consumption).



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### Delete

This key deletes the last character when entering parameters and is used for deleting stations from a file.

### Measure

This key starts a measurement.

- It works identically in both **Discharge** and **General** data collection modes.
- It is only active if the FlowTracker is displaying the current station information screen. It is not active when displaying data from a previous measurement.

### Corr. Factor

This key is used to enter special correction factors.

- The correction factor is used only in the **Discharge** mode.
- The correction factor is only used for certain situations.

### Next Station

This key is used to view the next station when scrolling through completed stations.

- It works identically in both **Discharge** and **General** data collection modes.
- It is not active during a measurement, or from the time **Measure** is used to start a station until the time the last measurement for that station is completed.
- In **Discharge** mode, stations are sorted/displayed by location (regardless of the order in which they were collected).
- In **General** mode, stations are displayed in the order they were collected.

### Set Velocity

This key is used to enter a user-estimated velocity. It is active only in **Discharge** mode for stations using the **Input V** method.

### Set Location

This key is used to set the measurement location.

- It sets the location value (**Loc**) in **Discharge** mode.
- It sets both the location 1 and location 2 values (**L1/L2**) in **General** mode.
- It can be used either for the current station (before the measurement) or to edit data from a previous station.

### LEW/REW

This key is used to specify the starting or ending edge of water.

- It is used only in the **Discharge** mode.
- **LEW** means “Left Edge of Water” and **REW** means “Right Edge of Water.” Your position is based on your body orientation when facing downstream.

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### Prev. Station

This key is used to view the previous station when scrolling through completed stations.

- It is not active during a measurement, or from the time **Measure** is used to start a station until the time the last measurement for that station is complete.
- In **Discharge** mode, stations are sorted/displayed by location (regardless of the order in which they were collected).
- In **Discharge** data collection mode, it will scroll past station 1 to the starting edge and starting gauge information.

### Set Measurement Depth

This key is used to set the measurement depth.

- It sets the measurement depth value (**MDep**).
- It can be used either for the current station (before the measurement) or to edit data from a previous measurement.

### Set Depth

This key is used to set the water depth (**Dep**). It can be used either for the current station (before the measurement) or to edit data from a previous station.

### Set Ice Depth

This key is used to set the ice depth.

- It is active only in **Discharge** mode.
- It sets the ice depth value (**Iddep**) as measured from the water surface to the bottom of the ice.
- It can be used either for the current station (before the measurement) or to edit data from a previous station.

### QC Menu

This key is used to access the **QC Menu** during data collection.

- It works identically in both **Discharge** and **General** data collection modes.
- The **QC Menu** includes the following functions:
  - Input supplemental data (gauge height, rated flow, and comments).
  - Accessing **QC Settings** and **Discharge Settings**.
  - Changing the averaging time for each measurement.
  - Display raw velocity data.
  - Run the automatic QC test.

### Method –

This key sets the method used for calculating the mean velocity in discharge measurements.

- It is active only in **Discharge** mode.
- This key changes the method to the *previous* method in the list.

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### **Method +**

This key sets the method used for calculating the mean velocity in discharge measurements.

- It is active only in **Discharge** mode.
- This key changes the method to the *next* method in the list.

### **Abort**

This key is used to stop data collection during a measurement.

- After pressing **Abort**, it can take 1-2 seconds to stop data collection.
- The FlowTracker will display a message saying that data collection was aborted and how much data were collected.
- You can accept the aborted measurement (using the mean values of the data that were collected) or repeat the measurement.

### **Calculate Disch.**

This key tells the FlowTracker to perform the final discharge calculation.

- It is active only in **Discharge** mode.
- It is active only when all stations have been completed and the **End Section** key has been pressed to enter the ending edge information.
- It is active only when the ending edge screen is displayed.
- The system will display a series of discharge screens showing final discharge data.

### **End Section**

This key is used to end a series of measurements. In **General** mode, it ends the series of measurements and displays the summary of all data collected.

- It is active only when the current station (not yet measured) is displayed.
- It takes a few seconds for the file to be closed before displaying the summary.
- In **Discharge** mode, this indicates that all stations have been collected.
- It ends the section and displays the ending edge screen. After this data has been entered, the final discharge calculation can be done.
- It is active only when the current station (not yet measured) is displayed.

### **ENTER**

This key serves several functions and works identically in both **Discharge** and **General** data collection modes.

- It is used to complete the entry of any user parameter.
- It is used to toggle between multiple display screens when available.
- It is used to acknowledge a FlowTracker system message.

## **3.3 Main Menu**

When turned on, the FlowTracker displays a wake up screen showing the firmware version and the date/time from the system clock (continually updating).

Example: FlowTracker 3.0 2006/06/01 08:10:25 Press Enter For Main Menu

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Pressing **Enter** displays the **Main Menu**.

Main Menu 1:Setup Parameters 2:System Functions 3:Start Data Run

From the **Main Menu**, press the appropriate key to access the desired function.

Press **1** for the **Setup Parameters Menu**.

Press **2** for the **System Functions Menu**.

Press **3** to start a data run.

**NOTE: It is important to always return to the Main Menu before turning the system off to ensure all data has been properly saved.**

### **3.3.1 Setup Parameters Menu (Main Menu <1>)**

Setup parameters determine how the FlowTracker collects data. This section describes each item in the **Setup Parameters Menu**.

1: Units English  
2: Avg. Time (40)  
3: Mode Discharge  
0=Exit or Enter=More

4: QC Settings  
5: Discharge Settings  
6: Salinity (0.00)  
0=Exit or Enter=More

7: Language English  
8: No Correction  
0=Exit or Enter=More

The **Setup Parameters Menu** is shown above (three screens are needed to show all options). Press **Enter** to cycle through the screens. To change a setting, press the appropriate menu number.

### **3.3.2 Units System (Setup Parameters <1>)**

The **Units** option defines the units system used for display and output data (set as **English**). The units system does not affect internal calculations or storage (internal units are metric).

To change the units system, press **1** from the **Setup Parameters Menu**, and then press **1** for **English** units.

### 3.3.3 Averaging Time (Setup Parameters <2>)

The **Avg Time** (averaging time) option specifies the amount of data (in seconds) to be collected at each measurement site. Averaging time is specified in 1-second intervals from 10 to 1000 seconds. Forty (40) seconds is the approved time.

To change the averaging time, press **2** from the **Setup Parameters Menu**.

### 3.3.4 Data Collection Mode (Setup Parameters <3>)

The **Mode** option determines the procedure when collecting a series of measurement stations.

To change the data collection mode, press **3** from the **Setup Parameters Menu**, and then press **1** for **Discharge** mode. In **Discharge** mode, a sequence of measurements is used to calculate river discharge (cfs).

### 3.3.5 QC Settings (Setup Parameters <4>)

The **QC Settings** menu sets universal QC criteria for **Discharge** mode.

To access the **QC Settings** menu, press **4** from the **Setup Parameters Menu**, and then:

- Press **1** to set the **SNR Threshold (>10dB)**
- Press **2** to set the  **$\sigma V$  Threshold (<0.03 ft/s)**
- Press **3** to set the **Spike Threshold (<10%)**
- Press **4** to set **Max Velocity Angle (<20 degrees)**

### 3.3.6 Discharge Settings (Setup Parameters <5>)

The **Discharge Settings** menu specifies settings for the discharge calculations and the QC criteria used for **Discharge** measurements.

To access the **Discharge Settings** menu, press **5** from the **Setup Parameters Menu**. You can also access **Discharge Settings** by pressing **3** from the **QC Menu** (although options **1**, **2**, and **3** are not available when a data file is open).

- Press **1** to set the discharge **Equation**.
- Press **1** to select **Mid Section**. Selecting this option sets **Repeat Depth** and **Repeat Velocity** to **NO**.

The section discharge (%Q) displayed for each station can be calculated based on either the user-supplied **Rated** discharge or the total **Measured** discharge.

Select the desired reference, **Rated** or **Measured**.

The default is **Rated**. If no **Rated** value is specified, the **Measured** value is used.

- Press **8** to select the **Methods Displayed**.

The FlowTracker supports several methods to determine mean velocity. The method determines the number and location of velocity measurements.

Scroll through available methods using the **Method+** and **Method–** keys.

- Press **1** to toggle **2-6-8 Methods (0.6, 0.2/0.8, 0.8/0.2, 0.2/.6/.8, 0.8/.6/.2)** on/off.

### 3.3.7 Salinity (Setup Parameters <6>)

The **Salinity** option specifies the salinity value used to compute sound speed.

To change salinity, press **6** from the **Setup Parameters Menu**, and then enter the desired salinity value in ppt.

Sound speed is used in Doppler velocity calculations (see *FlowTracker Principles of Operation* for details).

Salinity is specified in parts per thousand (ppt). Fresh water has a salinity of 0; seawater typically has a salinity of about 35 ppt.

As a rule of thumb, a 12-ppt error in the value of salinity will result in a 1% error in sound speed, which results in a 2% error in velocity data.

Salinity should be specified as accurately as possible for each location.

**NOTE: When using the FlowTracker in salt water, a sacrificial zinc anode should be installed on the probe for corrosion protection.**

### 3.3.8 Language (Setup Parameters <7>)

The FlowTracker firmware can operate in five different languages. Keypad labels are changed for compatibility with each language; keypad overlays are available on request for each language (and are included with each system shipped outside the United States and Canada).

To change the language, press **7** from the **Setup Parameters Menu**, and then press **1** for **English**.

### 3.3.9 Mounting Correction (Setup Parameters <8>)

**Mounting Correction** specifies how to account for the device used to hold the FlowTracker in the water. The mount may have a small impact on velocity measurements. Specifying the proper mounting correction allows the FlowTracker to account for the effect of the mount.

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To change the Mounting Type, press **8** from the **Setup Parameters Menu**:

- Press **1** for **No Correction** (the default setting).
- Press **2** for **Custom**. When prompted, enter a **Mounting Correction** for the mount being used.
- Contact SonTek for help in determining the appropriate **Mounting Correction**. The standard recommendation is 1.0%.

### 3.4 System Functions Menu (Main Menu <2>)

The **System Functions Menu** provides access to items that should be checked periodically but do not directly affect how data is collected. This section describes those items.

- 1: View Data File
- 2: Recorder Status
- 3: Format Recorder
- 4: Temperature Data
- 5: Battery Data
- 6: Raw Velocity Data
- 7: Auto QC Test
- 8: Show Config.
- 9: Set System Clock
- 0: Exit or Enter=More

Three screens are needed to show all items above. Press **Enter** to switch between screens. To change a setting, press the number shown.

#### 3.4.1 View Data File (System Functions <1>)

The **View Data File** option allows you to view data files stored on the internal recorder.

To view a data file stored on the internal recorder, press **1** in the **System Functions Menu**.

The FlowTracker will display a menu of the files on the internal recorder. At most, three files are displayed on each screen.

- Use **Enter** to scroll through the entire recorder directory (three files at a time).
- Press **1**, **2**, or **3** to select the desired file.
- Press **0** to exit the **View Data File** option without loading a file.

After loading the file, the FlowTracker displays a summary of the data file.

- Press **Enter** to move between the different summary display screens.
- Press **Previous Station** from any file summary screen to view station data.
- Use **Next Station** and **Previous Station** to scroll through station data (no new measurements can be added). The same station display screens are available as

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those used during data collection. Press **Enter** to scroll through the station data screens.

- Pressing **Next Station** from the last station returns you to the file summary screens.
- When done, press **0** to exit and return to the main menu. The **0** key is only active when the display is showing the summary data. If you have scrolled back to a previous station to view data, you will not be able to exit until you scroll forward to the summary data screen.

### 3.4.2 Check Recorder Status (System Functions <2>)

The **Recorder Status** option displays the number of files stored on the internal recorder and the number of files remaining.

To view the status of the recorder, press **2** from the **System Functions Menu**. Press any key to return to the main menu. The FlowTracker will have either a 2-MB or 4-MB recorder.

### 3.4.3 Format Recorder (System Functions <3>)

The **Format Recorder** option erases all data on the internal recorder.

To format the recorder, press **3** from the **System Functions Menu**.

The system will prompt you to enter **123** to confirm your decision to format (erase) the recorder. Entering any other value will abort the formatting process.

Be certain that all data has been downloaded before formatting the recorder; data cannot be recovered after the recorder is formatted.

Recorder formatting takes 20-60 seconds to complete.

### 3.4.4 Temperature Data (System Functions <4>)

The **Temperature Data** option displays the current temperature sensor data.

To view temperature data, press **4** from the **System Functions Menu**. Press any key to return to the main menu.

The temperature sensor is in the probe head and is accurate to +/- 0.1 °C.

### 3.4.5 Battery Data (System Functions <5>)

The **Battery Data** option shows the current battery voltage and an estimate of remaining capacity.



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To view battery data, press **5** from the **System Functions Menu**. Press any key to return to the main menu.

An estimate of remaining capacity (as a percent of total) is given for three battery types. The FlowTracker does not know what types of batteries are installed. Typical capacities:

- Alkaline: ≈25 hours
- NiMH: ≈15 hours
- NiCad: ≈7 hours

***Battery capacity estimates are based on voltage and are only approximate.***

***Cold weather can greatly affect battery voltage and capacity; always check battery voltage after the system has acclimated to outside temperatures.***

### **3.4.6 Raw Velocity Data (System Functions <6>)**

The **Raw Velocity Data** option shows a continuous display of raw velocity and SNR data.

To display raw data, press **6** from the **System Functions Menu**.

- This can also be accessed by pressing **5** from the **QC Menu**.
- Press any key to exit the raw velocity display.
- This can be done as a quick test before data collection or to check stream conditions during data collection. Data displayed during this function are not recorded.
- Velocity and SNR data are updated once per second.
- Velocity data can be expected to show notable variations (most of which are real), and should be indicative of the general conditions in the water.
- SNR is primarily a function of the amount of particulate matter in the water. For good conditions, SNR should be at least 10 dB. The system can operate effectively with SNR as low as 2-3 dB, although the noise in individual velocity measurements will increase.

### **3.4.7 Automatic QC Test (System Functions <7>)**

The Auto QC Test is an automated version of the *BeamCheck* software. This test can be run in three ways:

- When you are prompted to run this test at the start of each data file.
- When you press **7** from the **System Functions** menu.
- When you press **6** from the **QC Menu**.

Follow the instructions on the LCD. When the test is done and while a data file is open,

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results are recorded with the file. Place the probe in moving water well away from any underwater obstacles. The FlowTracker collects data for about 30 seconds. The data are analyzed based on several criteria:

Noise level

- Measured electronics noise level is compared to reference data. Any significant deviation causes a warning.
- A large change in noise level may indicate damage to the probe.

SNR

- The SNR is checked as sufficient for reliable data collection.
- Each beam SNR is compared to be sure all beams perform equally.
- A warning is issued for low SNR or if beam SNR values differ.

Peak shape

- The shape of the sampling volume curve is compared to the expected shape. Any significant deviation causes a warning.
- This criterion can only be checked with sufficient SNR (> 7 dB).

Peak location

- The physical location of the sampling volume is compared to the expected location. Any significant deviation causes a warning.
- This criterion can only be checked for sufficient SNR (> 7 dB).
- If any warnings are issued, you are given the option to repeat the test.

It is recommended that the test be repeated at least once after you verify that the probe and sampling volume are well away from any underwater obstacles.

If multiple warnings are received, run *BeamCheck* from a PC to evaluate FlowTracker performance in more detail.

### 3.4.8 Show System Configuration (System Functions <8>)

The **Show Config** option displays basic system configuration information.

To display system configuration information, press **8** from the **System Functions Menu**. Press any key to return to the main menu. Displayed items include:

- Firmware version number
- Serial number
- Probe type

**Side XY 10cm** indicates a side-looking 2D probe.

### 3.4.9 Set System Clock (System Functions <9>)

The **Set System Clock** option displays the date and time (continually updated) from the FlowTracker's internal clock.

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To change the date/time, press **9** from the **System Functions Menu**, and then follow the menu options to change the date or time.

### 3.5 QC Menu

The **QC Menu** is accessed only during data collection by pressing the **QC Menu** key (in either **Discharge** or **General** mode). It provides access to several functions.

Input supplemental data

- Supplemental data is provided to allow you to further document that data set.
- Up to 20 different supplemental data records can be included with each file.
- Each record can include gauge height, rated flow, user comments, a time stamp, and a location stamp.

The time stamp and location stamp are automatically generated with any gauge height, rated flow, or comment entries, but can be edited. Data in all records can be viewed and modified following the on-screen instructions in the **QC Menu**.

- Modify **QC Settings**
- Modify **Discharge Settings** (**Discharge** mode only)
- Change the averaging time (**Avg Time**) used for each measurement
- Display **Raw Velocity Data** from the FlowTracker without recording to a file
- One possible use for this function is to use the FlowTracker to locate the bottom of a slush layer under ice
- Run and record an additional **Auto QC Test**
- 

## 4.0 ESTABLISHING A FLOW DISCHARGE STATION

### 4.1 Basic FlowTracker Data Collection Process - Using the Keypad Interface

Pressing **3** from the main menu starts a data collection run. Press **1** to **Name** the data file. Enter the station ID using the keypad.

Find the previously established sample location and visually inspect the site for hazards both above and below the surface of the water. To minimize QC errors, spend time engineering the stream above your tag line by removing rocks, sticks, moss, and any other obstacles that may channelize water currents or cause back flow. Once you begin flow measurement, you may not move obstacles.

1. Stretch the tag line across the stream perpendicular to the stream flow.
2. The user proceeds through a series of measurement locations (a minimum of 20 stations and up to 100 stations can be recorded with each file).
3. At the start of data collection, you are prompted for a file name. Name this file for the Station Identification.

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4. The operator will next be prompted to **Run** or **Skip** the **Auto QC Test**. The **Auto QC Test** is essentially a field version of *BeamCheck* but is particular to the present measurement environment. This information is stored with each discharge measurement file and is displayed on the discharge measurement summary.
5. It is a requirement of all United States Environmental Protection Agency (EPA) and Environmental Services Assistance Team (ESAT) personnel to conduct an **Auto QC Test** prior to each discharge measurement.
6. Press **1** to **Run Test**.
7. The FlowTracker will collect 20 pings and either report that "All Results are Good" or that the test completed with warnings.
8. If a warning exists, Press **1** to **End Test** or Press **2** to **Repeat Test**. If the test is being repeated, move to a different place in the cross section free of potential boundary interference.
9. At this point of the procedure you are prompted to enter the **Starting Edge** of the cross section to be measured and will soon be collecting velocity data.
10. Press **LEW/REW (#4)** to toggle between the edges, and set the starting edge. The Right or Left edge of water is determined by your body orientation when facing downstream.
11. Press **Set Location** to enter the distance on the tagline for the starting edge of water. Press **Enter** when finished. You will not take a measurement at the Starting Location.
12. Press **Set Depth** to enter the depth of water at the particular location on the tagline. Press **Enter** when finished.
13. Press **Next Station (#2)** to continue the measurement.
14. The following sequence will occur at each successive location of the cross section. Generally, 20 - 25 evenly-spaced observations per cross section are sufficient to define the natural variability of the channel.
15. Press **Set Location** to enter the location on the tagline of the velocity observation. Press **Enter** when finished. The default observation spacing is one foot. Each successive observation sends you to the next point on the tagline based on the spacing of previous observations.
16. Press **Set Depth** to enter the depth of water at the observation point. Press **Enter** when finished. Each successive observation copies the depth of the previous point.
17. Depending on the depth of water at the observation point, the measurement method may differ in order to calculate mean velocity. Depths below 2 feet will use the 6/10<sup>ths</sup> method (the default setup on the FlowTracker). If the depth is above 2 feet, the 2/10<sup>ths</sup>- 8/10<sup>ths</sup> method is used. To toggle between the various methods, press **Method+**.
18. It is possible to recover if you mistakenly press **Measure** with an incorrect parameter or **Method**. Press **Abort** to terminate the measurement (or let the measurement finish), and press **2** to repeat the measurement. Until one measurement is accepted at a station, you have the ability to change all parameters. After one measurement

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has been accepted, **Method** can no longer be changed (although other parameters can still be changed).

19. Press **1** to **Accept** the data and move to the next station or location in the measurement series (e.g., advancing from the 2/10<sup>ths</sup> to 8/10<sup>ths</sup> observation depth).
20. Press **2** to **Repeat** the measurement, especially if QC issues arise. When a measurement is repeated, data are not lost. However, you will no longer be able to view the *old* data from the keypad interface. The *old* data are still recorded. Later, the data can be extracted in the raw data file (\*.dat) and the measurement summary file (\*.sum), but not in the discharge summary file (\*.dis).
21. Once a station is completed, the FlowTracker displays the next station. Location, depth, and method data for new stations are predicted using previous stations. If a multiple measurement method was used (e.g., 2/10<sup>ths</sup> and 8/10<sup>ths</sup> water depth), the next station will use the same method in the opposite order (i.e.; 8/10<sup>ths</sup> then 2/10<sup>ths</sup> depth).
22. Summary velocity and QC data are displayed at the end of each measurement. QC data is automatically reviewed. Values outside expected boundary limits generate a warning to the user. You are allowed to repeat individual measurements if desired.
23. You can scroll through previous stations to view data and edit station information.
24. When done, press **End Section**. For Discharge measurements, enter ending-edge information to be shown the final discharge data.
25. Press **Calculate Disch.** to finish the measurement. Press **Enter** to advance through the multiple screens. Any stations with a discharge greater than 10% must be re-evaluated. Do not end section and return to add stations on both sides of the station with greater than 10% discharge until all QC errors are satisfied.

**NOTE:** *It is important to always return to the Main Menu before turning the system off to ensure all data has been properly saved.*

## 5.0 EXPLANATION OF QC CRITERIA

### 5.1 Accessing QC Criteria

All QC criteria can be modified or disabled. All discharge measurements for EPA and ESAT field events should conform to the following criteria and are entered as the defaults in the ESAT FlowTrackers. To access QC settings:

From the Main Menu, press 1 for Setup Parameters.

From Setup Parameters, select 4 for QC Settings.

- Select 1 to specify SNR Threshold.
- Select 2 to specify  $\sigma V$  Threshold.
- Select 3 to specify Spike Threshold.
- Select 4 to specify Max Velocity Angle.

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From Setup Parameters, select 5 for Discharge Settings.

- Select 4 to specify Max Section Discharge.
- Select 5 to specify Max Depth Change.
- Select 6 to specify Max Location Change.

To disable any QC criteria, set that parameter to a value of 0.

### 5.1.1 Table 1-1 Quality Control (QC) Parameters

**Table 1-1. Quality Control (QC) Parameters**

Parameter	Description	Expected Values
<b>SNR</b> (§1.4.2)	<b>SNR</b> is the most important QC parameter. <ul style="list-style-type: none"> <li>• It measures the strength of the acoustic reflection from particles in the water.</li> <li>• Without sufficient SNR, the FlowTracker cannot measure velocity.</li> </ul>	Ideally > 10 dB Minimum ≥ 4 dB
<b><math>\sigma V</math></b> (§1.4.3)	$\sigma V$ (standard error of velocity) is a direct measure of the accuracy of velocity data. <ul style="list-style-type: none"> <li>• It includes the effects of turbulence in the river and instrument uncertainty.</li> </ul>	Typically < 0.01m/s (0.03 ft/s). Higher in turbulent environment.
<b>Boundary QC</b> (§1.4.4)	<b>Boundary QC</b> evaluates the measurement environment for interference from underwater obstacles. <ul style="list-style-type: none"> <li>• FAIR or POOR results may indicate significant interference from an underwater obstacle.</li> </ul>	BEST or GOOD
<b>Spikes</b> (§1.4.5)	<b>Spikes</b> in FlowTracker velocity data are removed using a spike filter. <ul style="list-style-type: none"> <li>• Some spikes are common and no cause for concern.</li> <li>• Too many spikes indicate a problem in the measurement environment (e.g., interference from underwater obstacles or highly aerated water).</li> </ul>	Typically < 5% of total samples. Should be < 10% of total samples.
<b>Angle</b> (§1.4.6)	<b>Angle</b> is the direction of the measured velocity relative to the FlowTracker X-axis. <ul style="list-style-type: none"> <li>• Used for discharge measurements only.</li> <li>• A good site should have small velocity angles.</li> <li>• Large angles may be unavoidable at some sites.</li> </ul>	Ideally < 20°
<b>%Q</b> (§1.4.7)	<b>%Q</b> is the percentage of the total discharge in a single measurement station. <ul style="list-style-type: none"> <li>• Most agencies have criteria for the maximum %Q.</li> </ul>	Typical criteria: Ideally < 5% Maximum < 10%

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## 5.1.2 Table 1-2 QC Warning Messages

**Table 1-2. QC Warning Messages**

Warning	QC Criteria	Description	Suggested Action
Low SNR (§1.4.2)	None	SNR < 4 dB	<ul style="list-style-type: none"> <li>Improve SNR (§8.6)</li> </ul>
Beam SNR (§1.4.2)	SNR Threshold	Difference in SNR for any 2 beams is > SNR Threshold.	<ul style="list-style-type: none"> <li>Look for underwater obstacles; repeat measurement.</li> <li>Check probe operation (§6.5).</li> </ul>
SNR Variation (§1.4.2)	None	One-second SNR data varies more than expected during a measurement. May indicate underwater interference or a highly aerated environment.	<ul style="list-style-type: none"> <li>Look for underwater obstacles; repeat measurement.</li> <li>Look for environmental sources (e.g., aerated water).</li> </ul>
SNR Change (§1.4.2)	SNR Threshold	SNR more than SNR Threshold different previous measurements; major change in measurement conditions.	<ul style="list-style-type: none"> <li>Look for underwater obstacles or other changes in river condition.</li> <li>Repeat measurement</li> </ul>
High $\sigma V$ (§1.4.3)	$\sigma V$ Threshold	$\sigma V > \sigma V$ Threshold; adjusted based on previous data and measured velocity. May indicate interference or a highly turbulent environment.	<ul style="list-style-type: none"> <li>Look for underwater obstacles or a change in conditions.</li> <li>Consider real turbulence levels in river.</li> <li>Repeat measurement.</li> </ul>
Bad Boundary QC (§1.4.4)	None	Boundary QC is FAIR or POOR. Indicates possible interference from underwater obstacles.	<ul style="list-style-type: none"> <li>Consider re-locating probe and repeating test.</li> <li>Measurement can proceed if results are consistent.</li> </ul>
High Spikes (§1.4.5)	Spike Threshold	Spikes > Spike Threshold percent of samples. May indicate poor measurement conditions.	<ul style="list-style-type: none"> <li>Look for underwater obstacles or unusual conditions (e.g., aerated water).</li> <li>Repeat measurement.</li> </ul>
High Angle (§1.4.6)	Max Velocity Angle	Angle > Max Velocity Angle. May only indicate non-ideal measurement environment.	<ul style="list-style-type: none"> <li>Consider if measured angle is realistic.</li> <li>Repeat measurement if needed.</li> </ul>
High %Q (§1.4.7)	Max Section Discharge	%Q > Max Section Discharge. Station contains a large portion of the total discharge.	<ul style="list-style-type: none"> <li>Consider adding more stations.</li> </ul>
Suspect Depth Value (§1.4.8)	Max Depth Change	Station depth differs from adjacent stations by more than Max Depth Change %. This may indicate a data entry problem.	<ul style="list-style-type: none"> <li>Verify station depth value.</li> <li>Re-enter if needed.</li> </ul>
Suspect Location Value (§1.4.9)	Max Location Change	Spacing between stations has changed by more than Max Location Change %. This may indicate a data entry problem.	<ul style="list-style-type: none"> <li>Verify station location value.</li> <li>Re-enter if needed.</li> </ul>
Location Out of Order / Location Outside Edge (§1.4.9)	None	Station location out of sequence or outside river edge. This may indicate a data entry problem.	<ul style="list-style-type: none"> <li>Verify station location value.</li> <li>Re-enter if needed.</li> </ul>

## 5.2 Signal-to-Noise Ratio (SNR)

SNR is a measure of the strength of the reflected acoustic signal relative to the ambient noise level of the FlowTracker. SNR is the most important QC data provided by the FlowTracker. An error may indicate interference from an underwater obstacle or a potential problem with the probe. At the first alert, repeat the measurement (perhaps after moving probe location). Some

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errors are unavoidable. Field conditions, such as turbulent water, may affect SNR and are unavoidable.

- SNR is reported in logarithmic units (dB). It is recorded with each one-second velocity sample. Mean values are recorded for each measurement location.
- For the best operating conditions, SNR should be greater than 10 dB.
- The FlowTracker can operate reliably with SNR as low as 4 dB, although the noise in individual measurements will increase.
- The FlowTracker displays an alert at the end of a measurement if SNR of any beam is <4.0 dB. SNR data are displayed during the measurement and with the measurement summary. For 2D systems, if the SNR of either beam is low, this will affect all velocity data even if the other beam shows higher SNR values.

Low SNR indicates a lack of suspended material in the water. For clear water, seeding material can be introduced to increase SNR. Seeding is typically only required in large laboratory tanks. Most field applications have sufficient natural scattering material.

The SNR data shown during data collection is the mean of the primary receivers (depending on the operating mode of the FlowTracker – either General or Discharge). Individual receiver data can be accessed after downloading the data file to a PC.

If the problem persists, run *BeamCheck* from a PC to evaluate FlowTracker operation in more detail. When the variation of SNR during a measurement (as measured by the standard deviation SNR data) is greater than a fixed threshold of 5 dB:

- This may indicate interference from an underwater obstacle, a highly turbulent environment, or highly aerated water.
- At the first alert, repeat the measurement (perhaps after moving probe location).
- If the problem persists, evaluate the measurement environment. In some cases, large variations may be unavoidable and may not impact the quality of velocity data.

**SNR Threshold** is checked with each measurement and when the **End Section** key is pressed in **Discharge** mode.

- You are notified of any stations that exceed the above criteria.
- If desired, you can go back and delete suspect stations and repeat the measurements.

### 5.3 Standard Error of Velocity ( $\sigma V$ )

Standard error of velocity ( $\sigma V$ ) is a direct measure of the accuracy of the mean velocity data.

$\sigma V$  can be directly interpreted as the accuracy of the mean velocity.

$\sigma V$  is calculated by dividing the standard deviation of one-second samples by the square root of the number of samples.



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$\sigma V$  is normally dominated by real variations in the flow and will vary depending on the measurement environment. When  $\sigma V_x$  is greater than the standard error threshold for that measurement:

- This may indicate interference from an underwater obstacle, a highly turbulent environment, or highly aerated water.
- At the first alert, repeat the measurement (perhaps after moving probe location).
- If the problem persists, evaluate the measurement environment. In some cases, large variations may be unavoidable (e.g., in highly turbulent waters).

**$\sigma V$  Threshold** is checked with each measurement and when the **End Section** key is pressed in **Discharge** mode.

- You are notified of any stations that exceed the above criteria.
- If desired, you can go back and delete suspect stations and repeat the measurements.

#### 5.4 Boundary Adjustment (Boundary QC)

The FlowTracker has a potential for acoustic interference from underwater objects. The **Boundary QC** test looks for interference with underwater objects that are in or close to the FlowTracker sampling volume. The system tries to avoid this interference, but you must be aware of system limitations.

- Reflections can occur from the bottom, the water surface, or submerged objects (e.g., rocks).
- If the sampling volume is on top of or beyond an underwater object, velocity data will be meaningless.
- When working in very shallow water or near underwater obstacles (with the sampling volume within 15 cm (6 in) of the obstacle), acoustic reflections can potentially affect velocity data.
- At each measurement location, the FlowTracker looks for these conditions, and if necessary, adapts its operation to avoid interference.
- For most locations, any required changes do not affect system performance.
- In some environments, changes may result in a lower maximum velocity. The FlowTracker records any changes required to avoid acoustic interference. It reports this as **Boundary QC**. This value describes the effect (if any) of boundary adjustments on performance.

The **Boundary QC** variable (**Bnd**) can have the following values (0 and 1 are the most common).

**0 (BEST):** No boundary adjustments were necessary, or if necessary, they have minimal impact on system performance. Maximum velocity is at least 3.5 m/s (11 ft/s).

**1 (GOOD):** Minor boundary adjustments were necessary with moderate impact on system performance. Maximum velocity is at least 2.5 m/s (8 ft/s).

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**2 (FAIR):** Larger boundary adjustments were necessary with notable impact on system performance. Maximum velocity is at least 1.2 m/s (4 ft/s).

**3 (POOR):** Major boundary adjustments were necessary with significant impact on system performance. Maximum velocity is less than 1.2 m/s (4 ft/s). The FlowTracker will still provide good performance for lower flows.

If the **Boundary QC** results are **FAIR** or **POOR**, this indicates possible interference, and the FlowTracker will issue an alert before the measurement is made. You are prompted to consider moving the probe to avoid this interference. If the probe is moved, repeat the boundary test prior to data collection. If repeated **Boundary QC** tests do not give improved results, you can proceed with the measurement but should carefully evaluate velocity data.

## 5.5 Spike Filtering

Spikes in velocity data occur with any acoustic Doppler velocity sensor such as the FlowTracker. Spikes may have a variety of causes – large particles, air bubbles, or acoustic anomalies.

- Velocity data from each FlowTracker measurement are evaluated to look for spikes.
- The number of spikes is displayed and recorded at the end of each measurement.
- The number of velocity spikes present in data is evaluated as follows.

The **Spike Threshold** (default 10%) is used as follows.

- If the number of spikes is a greater percentage of the total number of points than specified by the **Spike Threshold**, a warning is given.
- This may indicate interference from an underwater obstacle, a highly turbulent environment, or highly aerated water.
- At the first alert, repeat the measurement (perhaps after moving probe location).
- If the problem persists, evaluate the measurement environment. A large number of spikes may be unavoidable but may not overly impact the quality of velocity data.

**Spike Threshold** is checked with each measurement and when the **End Section** key is pressed in **Discharge** mode.

- You are notified of any stations that exceed the above criteria.
- If desired, you can go back and delete suspect stations and repeat the measurements.

## 5.6 Velocity Angle

In **Discharge** mode, an additional QC parameter is provided – *velocity angle*. Velocity angle is defined as the direction of flow relative to the upstream direction. The measured velocity angle is evaluated to ensure reliable data collection.

For an ideal discharge measurement site, flow should be perpendicular to the tag line used to define the cross section.

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- The FlowTracker's X-axis is always held perpendicular to the tag line.
- An angle of 0 degrees means flow direction is perpendicular to the tag line (as desired for an ideal measurement location).
- A good measurement site will typically show some flow variations but with all angles less than about 20-30 degrees.
- The **Max Angle** criterion (default 20°) is used as follows:
  - When measured angle is greater than **Max Angle**, a warning is given.
  - Evaluate the measurement site to verify the measured angle is reasonable.
  - Consider repeating the measurement if the angle does not appear reasonable (perhaps after moving probe location).

**Max Angle** is checked with each measurement and when the **End Section** key is pressed.

- You are notified of any stations that exceed the above criterion.
- If desired, you can go back and delete suspect stations and repeat the measurements.

## 5.7 Maximum Section Discharge

Most agencies monitoring discharge expect that no individual station should contain more than a certain percentage of the total discharge. The **Max Sect. Q** criterion (default 10%) alerts you if this standard is exceeded.

If the station discharge exceeds **Max Sect. Q** percent of the rated flow, a warning is issued, and you are prompted to consider adding another station on either side of the station in exceeding the 10% rule.

**Max Sect. Q** is also checked when the **End Section** key is pressed.

- You are warned if any station exceeds **Max Sect. Q** percent of total measured discharge.
- **If warned, you must go back and add more stations!**
- Add stations on each side of the station with the Maximum Section Discharge warning.

## 5.8 Maximum Depth Change

The **Max Depth Change** criterion (default 50%) is intended to avoid data entry errors. It is assumed that depth changes between stations will be gradual. If the entered depth is different from a reference by more than **Max Depth Change** (and at least 0.20 m; 0.66 ft), an alert is issued to be sure the depth was not incorrectly entered.

- If only the previous station is available, the newly entered depth is compared to the depth from the previous station.
- If depth data are available on both sides of this station, the newly entered depth is compared to an interpolated depth between the two adjacent stations.

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- You are prompted to verify the depth value or re-enter the depth.
- This criterion can be adjusted or disabled by setting **Max Depth Change** to 0.

**Max Depth Change** is also checked when the **End Section** key is pressed. You are notified of any stations that exceed the **Max Depth Change** criterion and are given the option to review all stations and modify any incorrectly entered data.

## 5.9 Maximum Location Change

The **Max Location Change** criterion (default 100%) is intended to avoid data entry errors. It is assumed that the spacing of adjacent stations will be nearly constant across the river. If spacing between stations has changed by more than **Max Location Change**, an alert is issued to be sure the location was not incorrectly entered.

- A 100% **Max Location Change** means the new station spacing is more than two times the previous station spacing. Any time a station location is changed, the location is compared to adjacent value(s) to see if the station is out of order. Collecting an out-of-order station is allowed. However, when an out-of-order station is entered, we verify the location value since the station is sorted into the correct place within the stream.

Any time a station location is changed, the location is compared to the starting edge location. If the new location is outside the starting edge, a warning is given.

## 6.0 BATTERY POWER

The FlowTracker uses eight AA batteries (alkaline, NiMH, or NiCad).

	Alkaline	NiMH (rechargeable)	NiCad (rechargeable)
New battery voltage	12.0 V	10.2 V	10.0 V
Approximate operating life	25 hours	15 hours	7 hours

To check FlowTracker battery level and estimated battery capacity:

- Press 5 from the **System Functions Menu**. Battery life estimates are at approximately 20°C (70°F). Cold weather greatly reduces battery capacity. Check battery capacity with the system acclimated to the outside temperature.

The batteries are accessed from the back of the FlowTracker handheld controller (Figure 1.0-1). To change the batteries, use the following steps:

- Turn the system off.
- Remove the six screws holding the battery compartment lid to the main housing.
- Remove the old batteries from the battery holder.
- Install the new batteries matching the orientation shown on the battery holder.
- Do not mix old and new batteries.

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- Do not mix different types of batteries.
- Secure the battery compartment lid using the six screws.
- Turn the system on and check the battery voltage level to ensure proper installation.

To avoid draining batteries when system is not in use, always turn the system off before storing the system.

If the system will not be used for more than one month, remove the batteries

## **7.0 HEALTH AND SAFETY**

When working in potentially hazardous situations, personnel must understand and comply with the site-specific Sampling and Analysis Plan/Quality Assurance Project Plan and Health and Safety Plan before the sampling event begins. More specifically, when entering a stream, hazardous situations exist that warrant the person performing the measurements wear adequate safety equipment, including a personal floatation device and waders with slip-resistant footwear.

## **8.0 REFERENCES**

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### Water Quality Measurements with the In-Situ® Multi-Parameter Meter

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#### APPROVED:

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This document has been prepared for the Environmental Protection Agency by the TechLaw, Inc. ESAT Region 8 Team and is intended to provide documentation of administrative, analytical and quality control procedures used in the daily performance of EPA and ESAT support services.

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## 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to document best practices in the use of the In-Situ® multi parameter water quality meter. For optimal performance, refer to the In-Situ® Multi-Parameter Troll® 9500 Operator's Manual and the Rugged-Reader® Operator's Manual.

## 2.0 SCOPE AND APPLICABILITY

This SOP is applicable only for In-Situ® water quality meters that are currently in use by United States Environmental Protection Agency (EPA) and Environmental Services Assistance Team (ESAT) field personnel. Water quality parameters may include pH, dissolved oxygen (DO), specific conductance, and temperature readings.

## 3.0 SUMMARY OF METHOD

Water quality measurements are a critical component of field sampling activities. Water quality meters are versatile tools for various measurements of water quality. For field sampling purposes, water quality meters are calibrated on site before use to account for barometric pressure. The main parameters for surface water quality are pH, DO, specific conductance, and temperature. These parameters are built in to the In-Situ® Rugged Reader® Troll® device and it's Pocket Situ 4 Software. Once calibrated, sampling teams have up to 24-hours to record water quality readings if barometric pressure conditions remain constant (see section 11.2). Data is recorded in a site-dedicated field logbook.

## 4.0 ACRONYMS AND DEFINITIONS

mg/L	milligram/liter
mL	milliliter
µS/cm	microsiemens/centimeter
DO	Dissolved Oxygen
EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
GPS	Global Positioning System
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response Standard
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
SAP/QAPP	Sampling and Analysis Plan/Quality Assurance Project Plan
SOP	Standard Operating Procedure

Health and Safety Plan (HASP): A site-specific plan that outlines safety hazards and hazard mitigation practices.

Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP): Site-specific documents that outline sampling and data quality objectives for a field sampling project.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).



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## **5.0 HEALTH AND SAFETY**

When working with potentially hazardous materials or in hazardous situations, personnel must understand and comply with the site-specific Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) and Health and Safety Plan (HASP) before the sampling event begins. When taking water quality readings in streams or surface impoundments containing known or suspected hazardous substances, adequate personal protective equipment (PPE) such as nitrile gloves, safety glasses, and waders, are necessary to prevent exposure. If entering a stream, safety equipment, including a personal floatation device and non-slip footwear should be worn in addition to general PPE. When taking measurements from a vessel in an impoundment or flowing waters, appropriate safety procedures and practices should be followed.

## **6.0 CAUTIONS**

To ensure safe and reliable operation of the equipment, the manufacturer's directions for transport, cleaning, decontamination, storage, and operation should be followed. See the operations manuals for additional guidance (Multi-parameter Troll® 9550 and the Rugged Reader®)

## **7.0 INTERFERENCES**

Improper calibration of the instrument can lead to erroneous readings or equipment malfunction. For each calibration standard, be sure to condition the instrument/probe with a rinse of the appropriate standard before calibration. Additionally, the hand held Rugged-Reader® unit should be fully charged before deployment to the field. If the unit fails to recognize the probe, make sure to check the batteries located in the upper part of the probe just below the interface cable connection. Note that batteries do not operate optimally in cold weather conditions.

## **8.0 PERSONNEL QUALIFICATIONS**

Any personnel involved with field sampling activities must be cleared for participation by their organization's health and safety officer. Clearance includes medical monitoring, respirator fit testing, and Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) 40-hour training. Personnel who will be collecting surface water quality data must be familiar with this and any other relevant SOPs, including the Sample Equipment Decontamination SOP FLD 02.00, Sample Preservation SOP FLD 03.00, Surface Water Sampling SOP FLD 01.00, Sample Custody and Labeling SOP FLD 11.00, and General Field Sampling Protocols SOP FLD 12.00.

## **9.0 EQUIPMENT AND SUPPLIES**

Equipment needed for collection of surface water quality data may include:

Water quality collection device – Multi-parameter Troll® 9550 and the Rugged-Reader®

PPE - personal floatation device, waders, gloves, proper footwear, safety glasses, insulating clothing for cold water, etc.

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Mapping and location tools – Global Positioning System (GPS) units, site/local area maps, compass, tape measure, survey stakes, pin flags, camera, 2-way radios

Documentation – field logbook or field data sheet(s)

Calibration standards - see Section 10.0, Standards and Reagents

## 10.0 STANDARDS AND REAGENTS

Certified standards are required for calibration of the Rugged Reader® In-Situ® water quality multi-parameter meter. pH calibration can be done at one to three points using buffer solutions at pH 4, 7, or 10. Specific conductance is calibrated with one point, usually at 1000 µS/cm. In addition to certified standards, it is best practice to also have spent standard, referred to as rinse, to use as probe conditioner in order to equilibrate the sensor. Refer to the Sampling Equipment Decontamination SOP FLD 02.00.

## 11.0 PROCEDURES

Commonly used procedures for the use of the Rugged Reader® In-Situ® water quality meter are provided in the following sections. Note that this equipment has many other functions, but only the most frequently used procedures for EPA Region 8 field activities will be discussed. For further information on potential uses and capabilities, consult the Rugged-Reader® and Troll® 9550 Operations Manuals.

### 11.1 Pre-Deployment Activities

Before field deployment, it is important to check the equipment for functionality. The batteries to the Rugged Reader® should be charged at least 24 hours prior to use. The Troll® 9500 requires two D-cell batteries. Calibration frequency varies between sensor types on the multi-parameter meter and environmental conditions. Consult calibration frequency requirements mandated by sampling event protocols or project data quality objectives. It is recommended that water quality sensors be stored, calibrated, and maintained in accordance with the In-Situ® multi-parameter Troll® 9500 operations manual. Sufficient time for thermal stabilization of standards to ambient conditions should be considered before calibration. To reduce the time for stabilization, all calibration standards and the In-Situ® equipment should be stored at the same temperature before starting calibration.

### 11.2 Field Water Quality Measurements – Calibration

Many sampling sites in EPA Region 8 are located at various elevations with differing barometric pressures, and as a result, re-calibration of the water quality sensors will occur at a greater frequency than manufacturer recommendations. Upon arrival on a site, it is recommended that a 500mL bottle of tap water be used to begin aeration of the optical DO sensor. Specific conductance and pH calibration can occur while the water aerates. In general, most mine effluent sites have pH values between 4.0 and 7.0; therefore, only a 2-point calibration with 4.0 and 7.0 pH buffer solutions is necessary. If deployed to a site where pH values are completely unknown, perform a 3-point calibration (adding the 10.0 calibration). Below are calibration procedures for pH, specific conductance, and DO measurements.

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### 11.2.1 pH Calibration

Connect the Troll® 9550 to the Rugged-Reader® with the interface cable and power on the unit. From the starting screen, tap **Start** (located on the upper right corner of the screen) with the stylus. The Start menu is the main access point to all programs, files, and settings loaded on the Rugged-Reader®. If this is the first time the Troll® 9550 is connected to the Rugged-Reader®, follow the instructions for using the Connection Wizard in the Rugged-Reader® Operations Manual (for subsequent uses, tap on the COM1-19200 line in the navigation window). If the Troll® 9550 is not recognized in the navigation window you may have to 'find' the device. Do this by tapping the COM port (labeled as COM1-19200) and then tap **Find** located in the lower right hand corner. The information for the Troll® 9550 should appear in the Rugged-Reader® navigation screen. If there is no connection to the Troll® 9550, check cable connections and/or battery status. Once the Troll® 9550 connection appears as a line in the navigation window, tap to open the **Parameters** option. Tap this twice in order to bring up the sensors that are currently connected to the probe (this should always be pH, specific conductance, DO, temperature, and barometric pressure). From this menu, tap **pH**. Three options will appear at the bottom of the screen, select **Calibrate**.

1. This will bring up the calibration setup menu. Select number of calibration points desired (usually 2). Select **Next**.
2. Start the pH calibration with the lowest standard. Use the pH 4.0 standard rinse to condition the sensor, empty the cup, and then place certified pH 4.0 standard in the calibration cup up to the fill level line. Press **Run**.
3. The sensors will take a few moments to stabilize for temperature and pH. Once stabilized, the screen will immediately prompt for the next standard. Follow the same procedure by first conditioning the sensor with the pH standard rinse, then fill the calibration cup with the certified standard. Press **Run** again.
4. Once the final calibration has stabilized, the user will be given the option to view the calibration report. Click **Yes** to view the report and record the final calibration results in the instrument-dedicated calibration logbook.

### 11.2.2 Specific Conductance Calibration

To calibrate for specific conductance, select the **Conductivity** option from the parameters menu by tapping it once, then select **Calibrate** by tapping it once. This will bring up the calibration setup menu.

1. This menu allows the user to select the standard intended for use. If the standard being used does not appear as one of the options, select **Other** to input the desired standard. Tap **Next**.
2. Condition the sensors by saturating with specific conductance rinse of similar concentration, and then fill the calibration cup with the certified standard. Make sure to fill the cup all the way to the fill line.
3. Once the calibration is stabilized, the user is given the option to view the calibration reports. Select **Yes** and record the new calibration results in the instrument-dedicated calibration logbook.

### 11.2.3 Dissolved Oxygen Calibration

Finally, the optical DO sensor should be calibrated. If the other parameters were calibrated first, there should have been sufficient time to saturate with oxygen (10-15 minutes). From the parameters menu, tap once on the **Rugged Dissolved Oxygen** icon, then once again on the calibration option at the bottom of the screen.

1. The first screen allows the user to edit the barometric setting. Select **Yes**.
2. The next screen will give the user options as to how the barometric setting should be calculated into the DO calibration. Select the **Use Vented Cable** option, and then tap **OK**.
3. The following screen gives the user the choice of 1) restoring default settings and calibrating, 2) restoring defaults and not calibrating, and 3) calibration only. Select the **Calibrate Only** option, and then tap **Next**.
4. Place the DO probe in the saturated tap water, then tap the **Run** button. The sensor will take a few moments to equilibrate for temperature and DO.
5. Once stabilized, the unit will prompt for a zero oxygen calibration. To skip this, simply tap the **Next** button. To finish the calibration, tap the **Finish** button.
6. The user will be given the option to see the calibration reports. Select **Yes** and record the calibration information in the instrument dedicated logbook.

### 11.3 Field Water Quality Measurements – Data Collection

Once calibration is complete, the user will be returned to the parameters screen. To begin collecting water quality data, tap the **Parameters** icon once, then the **Profiler** option once. The next screen will ask the user to assign a test name. Enable the keyboard icon on the bottom of the screen and type in the Location ID for the site that is to be sampled. Once finished entering the Test Name, tap **OK**. The screen will then display temperature, pH, specific conductance, DO, and barometric pressure data. Tap the icon on the bottom right of the screen that says **Continuous**. Allow several minutes for the readings to stabilize. Note: make sure the readings are within a certain range of expectation. Refer to previous readings at the site in the logbook to verify correct data ranges. Once the readings have stabilized, tap the icon **Stop Log**. Before exiting out of the screen, record the readings in a project dedicated field logbook. Data should be recorded in the following units for each parameter: pH, standard units; DO, mg/L; specific conductance,  $\mu\text{S}/\text{cm}$ ; and temperature,  $^{\circ}\text{C}$ . Once the data has been recorded in the logbook, tap the icon **Close** on the bottom right of the screen. To begin collecting data at a different site, repeat these exact steps found here in section 11.3.

### 11.4 Troubleshooting

When problems are noted during the calibration procedure, check the following:

1. Make sure the parameter shown on the screen is the same parameter to which the unit is being calibrated.
2. Make sure the proper standard is being used for its corresponding calibration value (i.e. make sure not to calibrate specific conductance with a pH standard).
3. Verify that the standards used have not been contaminated.
4. Make sure the equipment and solutions are at the correct temperature for the

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- calibration being performed.
5. Be sure to fill the calibration cup according to directions in the Troll® 9550 operations manual.
  6. Make sure the pH reference electrode was filled with the proper pH filling solution.
  7. Check the multi-probe housing and sensors for physical damage (cracked or bent electrodes) and fouling (tarnished, soiled, color change, or otherwise coated electrodes).
  8. Check the multi-probe battery status. Recharge the unit if there are only one or two bars showing in the battery icon in the opening screen. There is also a battery voltage indicator under the parameters screen in the Pocket-Situ 4 software. If the Troll® 9550 batteries are running low, quit the Pocket Situ 4 software and replace the D-cell batteries.
  9. If the above troubleshooting tips and maintenance procedures do not solve the problem, contact In-situ® technical support at 1-970-498-1500 or toll free at 1-800-466-1500 (Option 3).
  10. If problems persist, refer to the In-situ® operator's manual. All In-situ® cases will include a copy of the operator's menu.

## **12.0 DATA RECORDS AND MANAGEMENT**

All data and measurements must be recorded in the site-dedicated field logbooks. This data will be entered into a spreadsheet and published in Scribe. Any recording errors should be struck out with a single line through the incorrect value, initialed by the recorder, and then re-recorded with the correct value. All calibration or repair data should be recorded in the equipment-dedicated field logbook.

## **13.0 QUALITY CONTROL AND ASSURANCE**

EPA and ESAT Region 8 personnel who use these instruments will calibrate the In-situ® each day before use and will perform maintenance procedures as needed. If personnel feel uncertain about the quality of measurement data in the field, performance of the instrument will be checked using a known calibration standard. Corrective actions will be determined on a case by case basis with all circumstances being considered. Data will be flagged as needed in the final data package.

## **14.0 REFERENCES**

EPA Guidance for Preparing Standard Operating Procedures, EPA QA/G-6, April 2007.

In-Situ, Inc. Multi-Parameter TROLL® 9500 Operator's Manual. Rev. 007, January 2009.

In-Situ, Inc. Rugged Reader® Operator's Manual. October 2007.

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### Sample Custody and Labeling

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#### APPROVED:

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ESAT Region 8 QA Coordinator

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ESAT Region 8 Team Manager

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ESAT Region 8 Task Lead

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## **1.0 PURPOSE**

The purpose of this Standard Operating Procedure (SOP) is to assist field personnel in developing proper sample custody and sample identification methods for the collection of environmental samples. This includes the use of chain of custody (COC) forms and labels for samples collected in the field. These procedures are critical in ensuring the integrity of environmental samples.

## **2.0 SCOPE AND APPLICABILITY**

To ensure the integrity of a sample collected in the field or generated in a laboratory setting, documentation is needed to chronicle all sample handling for collection or creation through analysis and/or disposal. Any sample that is collected in the field or generated in a laboratory setting will require that records are kept as it transfers from various entities. This is the basis for generation of a COC. Uniquely, labeling samples with information, such as sample location, date, time, preservation method, and analytical requirements, keeps samples organized. A COC is initiated for each sample, either at the time of sample collection or generation or as part of preparation for a sampling event. This SOP will cover the best practices for sample custody and the method of COC and label generation.

## **3.0 SUMMARY OF METHOD**

Once a sample is collected, several steps need to be taken to ensure the required information is collected and maintained as it is transferred from the point of collection to the laboratory. If sample nomenclature and location is known before a field event, a COC will be generated before deployment into the field. When generating the COC, it is important to know the analytical fate of samples required for each sample location (e.g. total recoverable metal, dissolved metals, etc.). This information can be found in the site-specific Sampling and Analysis Plan (SAP) and other sampling event planning documents. Some software programs (e.g. Scribe) that generate COCs also have the ability to generate labels. Scribe is the Laboratory Information Management System (LIMS) used by the lab. It is important to keep in mind that it is not mandatory to generate COCs and labels before a sampling event, but it is preferred. If it is not known where samples will be collected or the nomenclature of the sites is unclear, sample containers can be labeled with permanent marker with tape placed over it, and a blank COC can be filled out at the time of sample collection. Once the method of custody is established, a specific person, known as the sample custodian, is then responsible for maintaining the integrity of the samples as they move from and within various locations.

## **4.0 ACRONYMS AND DEFINITIONS**

CLP	Contract Lab Program
COC	Chain of Custody
EPA	United States Environmental Protection Agency
ERT	Environmental Response Team
ID	Identification
LIMS	Laboratory Information Management System
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure



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Chain of Custody (COC): A document used to chronologically track movement of samples between entities from collection to disposal.

Sampling and Analysis Plan (SAP): A site-specific document that describes the events to take place in the field.

Scribe: – A software tool developed by the United States Environmental Protections Agency (EPA) Environmental Response Team (ERT) to assist in the process of managing environmental data. Scribe captures sampling, observational, and monitoring field data.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

## **5.0 HEALTH AND SAFETY**

There are no specific health and safety hazards associated with sample custody and labeling, but these activities sometimes take place on-site during a sampling event. It is important for field personnel to familiarize themselves with the site-specific Health and Safety Plan before deployment to a site. In terms of personal interaction with the sample throughout the process of sample custody, there exists the possibility that the samples can leak. It is important to be aware of such hazards, especially when interacting with samples that are highly contaminated.

## **6.0 CAUTIONS**

Samples sometimes require specific storage and maintenance, such as temperature preservation requirements. Proper storage of samples is critical in maintaining their integrity. Labeling is also critical in the process of sample custody. Samples usually are labeled with a series of letters and numbers that correspond to a site location, which sometimes are very similar to each other. Sample nomenclature will be designated in the approved SAP and will be followed in the field. Once a COC or label is generated, it is very important to have it reviewed for quality assurance purposes. Sample label and COC review is necessary to ensure that they match site documents.

## **7.0 INTERFERENCES**

Once a COC and group of labels are reviewed and deployed, it is critical that the proper label ends up on the correct sample container. There will be more than one subsample collected at the majority of sampling locations in the region. This means that sample numbers can be very close in nomenclature, which puts more emphasis on attention to detail when labeling the sample containers. If the wrong label is attached to a sample, it may result in improper preservation, improper analysis, or rejection by the analytical laboratory.

## **8.0 PERSONNEL QUALIFICATIONS**

It is critical that field personnel have proper clearance and health and safety training. Anyone who performs sample custody activities should also familiarize themselves the site-specific SAP and Quality Assurance Project Plan (QAPP), as well as with applicable SOPs: Surface Water Sampling SOP FLD 1.00, Groundwater Sampling SOP FLD 04.00, Soil Sampling SOP FLD 5.00, Pore Water Sampling SOP FLD 10.00, and Shallow Stream Sediment Sampling SOP FLD 06.00.

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## **9.0 EQUIPMENT AND SUPPLIES**

Below is a list of equipment and supplies required for COC activities (refer to the site specific SAP for additional items that maybe needed:

- Scribe software
- A SAP that details sample locations and analytical requirements
- Printer (that accepts corresponding labels)
- Blank COC pages in case of unexpected opportunistic sampling
- Permanent marker for preliminary labeling
- Clear tape for label protection from moisture
- Printable labels
- Field Logbook

## **10.0 STANDARDS AND REAGENTS**

There are no standards or reagents associated with this SOP.

## **11.0 PROCEDURES**

The following sections outline the general procedures for sample custody and labeling, filling out COCs with the proper information, and relinquishing samples. See Attachment A for an example of a blank COC and Attachment B for an example of a sample label.

### **11.1 Generating a Blank COC and Sample Labels**

There are several types of data management software that can be used to generate COCs and labels. Scribe is used at the EPA Region 8 laboratory. Some training is required before an individual can use Scribe; however, once the basics of Scribe are understood, it can be used to generate COCs and labels for any type of sample or analysis. A COC that is generated prior to deployment should have the following information:

- Site Identification
- Analysis to be performed
- Preservation
- Tag Identification

The following information should not be filled out until sampling occurs:

- Date
- Time
- Sampler identification
- Comments describing anomalies

Labels can be produced with the same information found in the COCs.

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## **11.2 Populating COC Fields and Affixing Labels**

Sample containers should always be marked with a permanent marker with the site identification (ID), time of collection, analysis to be performed, date, and sampler initials prior to sample collection. Once samples have been collected, and a safe place to fill out COC and labels is established, field personnel should fill out the pre-populated COCs and labels with information such as date, time of collection, sampler initials, and comments. It is imperative that the information written on the sample container in permanent marker is the same information on the sample labels and the COC. The same information should also be recorded in a site-dedicated field logbook.

Once the labels have been verified to have the correct information, they should be affixed to the sample containers. Always be sure to double check that the proper label is placed on the corresponding sample container by cross-referencing it with the markings. Once the label is affixed to the sample container, place clear packing tape over the label and wrap completely around the container. This will prevent moisture from dissolving the label adhesive and blurring the writing. It also prevents holes, knicks, or tears from rendering the label unreadable.

## **11.3 Review/Custody Transfer**

Once sample information is written on the COC and labels, and the label IDs have been verified against the permanent marker ID on the container, they are then ready for transfer of custody. Whether the samples are going to the EPA Region 8 lab or a Contract Lab Program (CLP) laboratory partner, the samples must be properly shipped at the required temperature (4°C for water and sediment samples) and done so in a way that containers are not compromised. In order to not compromise the integrity of the samples, the handler needs to make sure the cooler or other transporting vessel is not dropped, exposed to moisture or extreme weather, or in any other way disturbed. A signed copy of the COC intended for the receiving laboratory (samples IDs and event information should not be viewable to the lab) must be included in the shipping container. If samples are returning to the Region 8 Laboratory, they should be properly stored on ice in the field until delivered to the lab. To protect against sample contamination, place the ice in the coolers in plastic bags. When at the lab, samples should be placed in the walk-in coolers located in the sample receiving room. A signed copy of the COC is given to the sample receiving coordinator. In order to ensure samples are transferred to the correct party with the appropriate information and communication, a mutual signing of the COC by the sampler or transport agency and the sample coordinator can be arranged.

## **12.0 DATA RECORDS AND MANAGEMENT**

As mentioned earlier, a COC should have information such as site ID, sample location, sample time, sample date, sampler initials, analytical requirements, sample matrix, preservative type, and a comments field. A sample label should have information such as sample location, time, date, matrix, preservative, and sampler initials. Any other field observations that require an explanation should be noted in the field forms or site-dedicated field notebook. Data such as sample ID, time, date, field parameters, (pH, temperature, conductivity, and dissolved oxygen) and sampler initials will eventually be entered into Scribe.

Replaces SOP: N/A

Containers Intact: Y N

Received By:

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**Attachment B: Example Sample Label**

**Sample # 082X-127      Sampler:**  
**Tag: A**  
Date:                      Sample Time:  
Location: Dup-05              Samp\_Depth:  
Analyses: Total Recoverable Metals  
Preservation: TR\_Plastic Baggie

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## General Field Sampling Protocols

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### APPROVED:

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## **1.0 PURPOSE**

The purpose of this Standard Operating Procedure (SOP) is to provide general field sampling guidelines that will assist Environmental Protection Agency (EPA) and Environmental Services Assistance Team (ESAT) personnel in choosing sampling strategies, location, and frequency for proper assessment of site characteristics. This SOP is applicable to all field activities that involve sampling.

## **2.0 SCOPE AND APPLICABILITY**

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

## **3.0 SUMMARY OF METHOD**

Sampling is the selection of a representative portion of a larger population, area or body. Through examination of a sample, the characteristics of the larger entity from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment. The sampling design is a fundamental part of data collection for scientifically based decision making. A well-developed sampling design plays a critical role in ensuring that data are sufficient to draw the conclusions needed. The goals of a sampling design can vary widely. Typical objectives of a sampling design for environmental data collection are:

- To support a decision about whether contamination levels exceed a threshold of unacceptable risk
- To determine whether certain characteristics of two populations differ by some amount
- To estimate the mean characteristics of a population or the proportion of a population that has certain characteristics of interest
- To identify the location of "hot spots" (areas having high levels of contamination) or plume delineation
- To characterize the nature and extent of contamination at a site
- To monitor trends in environmental conditions or indicators of health

A well-planned sampling design is intended to ensure that resulting data are adequately representative of the target population and defensible for their intended use. Representativeness may be considered as the measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Throughout the sampling design process, the efficient use of time, money, and human resources are critical considerations. A good design should meet the needs of the study with a minimum expenditure of resources. If resources

## **4.0 ACRONYMS AND DEFINITIONS**

EPA	United States Environmental Protection Agency
ESAT	Environmental Services Assistance Team
DOT	Department of Transportation



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HAZWOPER	Hazardous Waste Operations and Emergency Response
IATA	International Air Transport Association
MI	Multi-increment
OSHA	Occupational Safety and Health Administration
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure

Occupational Safety and Health Administration (OSHA): A regulatory agency that governs health and safety standards in the United States.

Standard Operating Procedure (SOP): A set of written instructions that document a routine or repetitive activity followed by an organization (EPA, 2007).

Quality Assurance Project Plan (QAPP): A site-specific document that specifies quality assurance activities and data quality objectives.

## **5.0 HEALTH AND SAFETY**

When working with potentially hazardous materials, follow U.S. Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA) and corporate health and safety procedures. Always review the site Health and Safety Plan (HASP) before beginning work at any site.

## **6.0 CAUTIONS**

In general, health and safety of field team members and sample/data integrity are the two main concerns during a field sampling event. Field personnel must understand sampling procedures and be familiar with health and safety protocols before deployment to a site. Always consult the HASP before entering a site.

## **7.0 INTERFERENCES**

The nature of the object or materials being sampled may be challenging to characterize. If a material is homogeneous, it will generally have a uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous samples present problems to the sampler because of spatial and temporal changes in the material. Samples of hazardous materials may pose a safety threat to both field and laboratory personnel. Proper health and safety precautions should be implemented when handling this type of sample. Environmental conditions, weather conditions, or non-target chemicals may cause problems and/or interferences when performing sampling activities or when sampling for a specific parameter. Refer to the specific SOPs for sampling techniques.

## **8.0 PERSONNEL QUALIFICATIONS**

All personnel who participate in field activities are required to obtain clearance in three mandatory health and safety programs: medical monitoring, respirator fit testing, and OSHA Hazardous Waste Operations

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and Emergency Response (HAZWOPER) 40-hour training. In addition, any personnel who will participate in sampling activities must read, understand, and sign the site-specific HASP and associated Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP).

## **9.0 EQUIPMENT AND SUPPLIES**

The equipment required to collect samples must be determined on a site-specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment required for sampling.

## **10.0 STANDARDS AND REAGENTS**

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP FLD 02.00.

## **11.0 PROCEDURES**

### **11.1 Types of Samples**

In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample.

Environmental samples are those collected from streams, ponds, lakes, wells, and are off-site samples that are not expected to be contaminated with high levels of hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree. The importance of making the distinction between environmental and hazardous samples is two-fold:

1. Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel. Personnel handling potentially hazardous substances should always wear proper Personal Protective Equipment.
2. Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association (IATA) Dangerous Goods Regulations or Department of Transportation (DOT) regulations and U.S. EPA guidelines.

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## **11.2 Sample Collection Techniques**

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

### Grab (Discrete) Samples

A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

### Composite (Multi-Increment) Samples

Multi-increment (MI) or composite sampling is a structured sampling protocol that reduces data variability and increases sample representativeness. The objective of MI sampling is to obtain a single sample for analysis that has a mean analyte concentration representative of the decision unit. The decision unit size is site-specific and represents the smallest area on which to base a decision or conclusion. Samples are collected from multiple locations within the decision unit and composited so the samples are spatially representative of the decision unit. The decision unit must be defined so that the results are relevant to explicitly articulated sampling objectives. Note that establishment of decision units is necessary to develop any effective sampling approach, whether using MI or discrete sampling.

The MI sampling strategy improves the reliability and defensibility of sampling data by reducing their variability compared to conventional discrete sampling strategies. The data distribution for MI replicate samples tends to be normally distributed, as contrasted to the positively skewed distribution seen with discrete samples. Fewer non-detect results can be expected using MI, thus mitigating problems caused by using censored data sets and lessening the chance of missing significant contamination. In addition, levels of statistical confidence and decision uncertainty that would require a large number

## **11.3 Types of Sampling Strategies**

It is important to select an appropriate sampling approach for accurate characterization of site conditions. Prior to undertaking any sampling program, it is necessary to establish appropriate measurement and system Data Quality Objectives. Refer to the U.S. Environmental Protection Agency (EPA) Soil Sampling Quality Assurance User's Guide (listed in Section 14.0 References) for guidance in establishing Data Quality Objectives, statistical sampling methodologies and protocols for each of the sampling approaches. Each approach is defined below.

### Judgmental or Biased Sampling

Judgmental or Biased sampling is used primarily for documenting an observed release to the groundwater, surface water, air or soil exposure pathways. This form of sampling is based on the subjective selection of sampling locations where contamination is most likely to occur. Locations are based on relative historical site information and on-site investigation (site walk-over) where contamination is most likely to occur.

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There is no randomization associated with this sampling approach because samples are primarily collected at areas of suspected highest contaminant concentrations. Any statistical calculations based on the results of this sampling technique will be biased.

#### Random Sampling

Random sampling, used for the characterization of a heterogeneous non-stratified waste, involves arbitrary collection of samples within a defined area. This method is most effective and accurate if the chemical heterogeneity of the waste remains constant from batch to batch. The easiest method for Random Sampling is to divide the area for sampling into an imaginary grid, assign a series of numbers to the units of the grid, and select the numbers or units to be sampled through the use of a random-numbers table which can be found in the text of any basic statistics book. Note that haphazardly selecting sample numbers or units is not a suitable substitute for a randomly selected sample.

#### Stratified Random Sampling

Stratified random sampling, used for the characterization of a heterogeneous stratified waste, involves arbitrary collection of samples within a defined area and strata. This method is most effective and accurate if the chemical heterogeneity of the waste remains constant from batch to batch. The easiest method for stratified random sampling is to divide the area for sampling into an imaginary grid, assign a series of numbers to the units of the grid, and select the numbers or units to be sampled through the use of a random-numbers table which can be found in the text of any basic statistics book. A random sample is then collected from each strata at the selected numbers or units on the grid. Note that haphazardly selecting sample numbers or units is not a suitable substitute for a randomly selected sample.

#### Systematic Grid Sampling

Systematic grid sampling involves dividing the area of concern into smaller sampling areas using a square or triangular grid. Samples are then collected from the intersection of the grid lines or nodes. The origin and direction for placement of the grid should be selected by using an initial random point. The distance between nodes is dependent upon the size of the site or area of concern and the number of samples to be collected. Generally, a larger distance is used for a large area of concern.

#### Systematic Random Sampling

Systematic random sampling involves dividing the area of concern into smaller sampling areas. Samples are collected within each individual grid cell using random selection procedures.

#### Search Sampling

Search sampling utilizes a systematic grid or systematic random sampling approach to define areas where contaminants exceed clean-up criteria. The distance between the grid lines and number of samples to be collected are dependent upon the acceptable level of error (i.e., the chance of missing a hot spot). This sampling approach requires that assumptions be made regarding the size, shape, and depth of hot spots.

#### Transect Sampling

Transect sampling involves establishing one or more transect lines, parallel or non-parallel, across the area of concern. If the lines are parallel, this sampling approach is similar to systematic grid sampling. The advantage of transect sampling over systematic grid sampling is

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the relative ease of establishing and relocation transect lines versus an entire grid. Samples are collected at regular intervals along the transect line at the surface and/or at a specified depth(s). The distance between the sample locations is determined by the length of the line and the number of samples to be collected.

#### **11.4 Quality Assurance Project Plans (QAPP)**

A Quality Assurance Project Plan (EPA, 2006) is required when it becomes evident that a field investigation is necessary. It should be initiated in conjunction with, or immediately following, notification of the field investigation. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities:

- Objective and purpose of the investigation
- Basis upon which data will be evaluated
- Information known about the site including location, type and size of the facility, and length of operations/abandonment
- Type and volume of contaminated material, contaminants of concern (including concentration), and basis of the information/data
- Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rationale, and SOPs or description of the procedure to be implemented
- Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables
- QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives

Note that this list of QAPP components is not all-inclusive and that additional element(s) may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAPP is quite important, it may be impractical in some instances. Emergency responses and accidental spills are prime examples of such instances where time might prohibit the development of site-specific QAPPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgment, and the sampling or response plans might simply be a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

#### **11.5 Legal Implications**

The data derived from sampling activities are often introduced as critical evidence during litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities.

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Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are questionable, invalid and non-defensible in court, and the consequent loss of enforcement proceedings.

## **12.0 DATA RECORDS AND MANAGEMENT**

There are many data parameters and custody records that require attention to detail. Refer to the specific SOPs for data management activities that are associated with sampling techniques.

## **13.0 QUALITY CONTROL/QUALITY ASSURANCE (QC/QA)**

Refer to the specific SOPs for the type and frequency of QA/QC samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QA/QC activities which are associated with sampling techniques.

## **14.0 REFERENCES**

EPA Guidance for Preparing Standard Operating Procedures, EPA QA/G-6. April 2007.  
EPA Guidance on Systematic Planning using the Data Quality Objectives Process (QA/G-4).  
February 2006.

EPA Guidance on Choosing a Sampling Design for Environmental Data Collection (QA/G-5S).  
December, 2002